

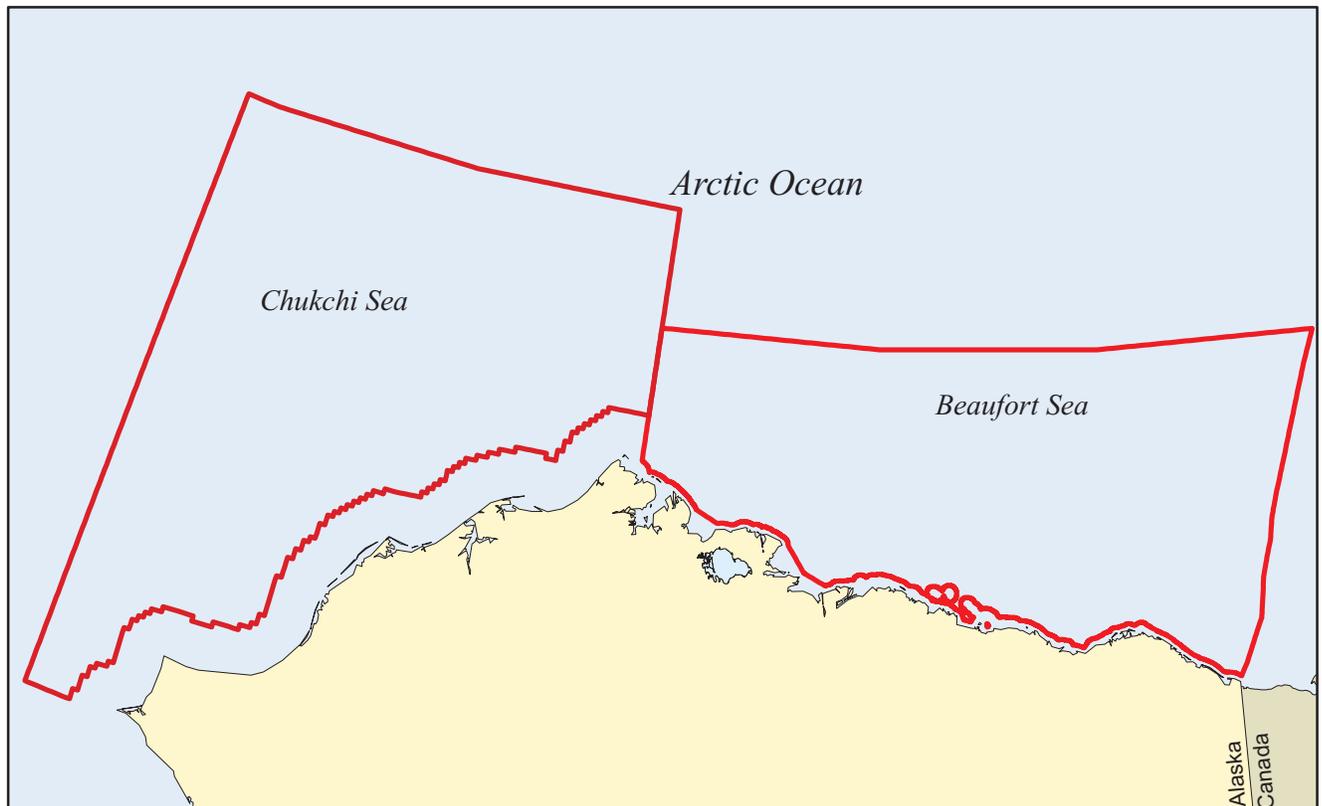


Beaufort Sea and Chukchi Sea Planning Areas

Oil and Gas Lease Sales 209, 212, 217, and 221

Draft Environmental
Impact Statement

Volume II Chapter 4.4



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Volume II

Chapter 4.4 - Environmental Consequences Beaufort Sea

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ACRONYMS

Acronyms

AAC	Alaska Administrative Code	BLM	Bureau of Land Management
ABWC	Alaska Beluga Whale Committee	BO	Biological Opinion
ACC	Alaska Coastal Current	BOD	biological oxygen demand
ACIA	Arctic Climate Impact Assessment	BOE	barrels of oil energy equivalent
ACMP	Alaska Coastal Management Program	B.P.	Before Present
ACP	Arctic Coastal Plain	BP	British Petroleum
ACS	Alaska Clean Seas	bpd	barrels per day
ACW	Alaska Coastal Water	BPXA	BP Exploration (Alaska), Inc.
ADEC	Alaska Department of Environmental Conservation	BRFSS	Behavioral Risk Factor Surveillance Study
ADF&G	Alaska Department of Fish and Game	BS	Boundary Segment
ADNR	Alaska Department of Natural Resources	BSU	Barrow Service Unit
AES	ASRC Energy Services	BTEX	benzene, toluene, ethylbenzene, and xylene
AEWC	Alaska Eskimo Whaling Commission	BWASP	Bowhead Whale Aerial Survey Program
AGIA	Alaska Gas Inducement Act	CAA	Clean Air Act, also conflict avoidance agreement
AGL	above ground level	CAH	Central Arctic Caribou Herd
AGS	Alaska Gas System	Call	Call for Information and Nominations
AHRS	Alaska Heritage Resource Survey	CANIMIDA	Continuation of Arctic Nearshore Impact Monitoring in Development Areas
AI/AN	American Indian and Alaskan Native	CDC	Centers for Disease Control
AIS	aquatic invasive species	CDFO	Canadian Department of Fisheries and Oceans
AIW	Atlantic Intermediate Water	CBD	Center for Biological Diversity
AMMP	Adaptive Management and Mitigation Plan	CDFO	Canadian Department of Fisheries and Oceans
ANGTS	Alaska Natural Gas Transportation System	CEQ	Council on Environmental Quality
ANHB	Alaska Native Health Board	CER	Categorical Exclusion Review
ANILCA	Alaska National Interest Land Conservation Act	CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Areas	CFC	chlorofluorocarbons
ANMC	Alaska Native Medical Center	CFR	Code of Federal Regulations
ANTHC	Alaska Native Tribal Health Consortium	CH ₄	methane
ANWR	Arctic National Wildlife Refuge	CHAP	Community Health Aide Program
AO	Arctic Oscillation	CI	confidence interval
AOGMC	atmosphere-ocean general circulation models	CIDS	concrete island drilling system
APD	Application for Permit to Drill	CIP	Capital Improvements Project
APF	Alaska Permanent Fund	CITES	Convention on the International Trade in Endangered Species
Area ID	Area Identification	cm	centimeter(s)
ARBE	Arctic Region Biological Evaluation	cm/sec.	centimeter(s) per second
ARRT	Alaska Regional Response Team	CI	confidence interval
ASL	above sea level	CIAP	Coastal Impact Assistance Program
ASRC	Arctic Slope Regional Corporation	CMP	Coastal Management Program
ATV	all-terrain vehicle	CO	carbon monoxide
AWIC	Arctic Women in Crisis	COPB	chronic obstructive pulmonary disease
bbl	barrel(s)	COY	cubs of the year (polar bear)
Bbbl	billion barrels (of oil)	cP	centipoise (measure of viscosity and emulsification of oil)
Bcf	billion cubic feet (of gas)		
BE	Biological Evaluation		

Acronyms

CS	Chukchi Sea (population of polar bears)	ft ³	cubic feet/foot
		FY	Fiscal Year
CSSP	Climate Change Science Program	G&G	Geological and Geophysical permit
CWA	Clean Water Act	g/m ²	gram(s) per square meter
CYP1A	cytochrome P4501A	gal	gallon(s)
CYS	Children & Youth Services	GIS	Geographic Information System
CZARA	Coastal Zone Act Reauthorization Amendments of 1990	GLS	grouped land segments
		GPR	ground-penetrating radar
CZMA	Coastal Zone Management Act	GWP	global warming potential
CZMP	Coastal Zone Management Plan	HAPs	hazardous air pollutants
dB	decibel(s)	HEC	Health Effect Category
DEW	Defense Early Warning	Hz	Hertz
DHHS	(U.S.) Department of Health and Human Services	IAP	Integrated Activity Plan
		IBHS	Integrated Behavioral Health Services
DLP	defense of life and property		
DM	Department Manual	ICAS	Inupiat Community of the Arctic Slope
DMT	Delong Mountain Terminal		
DOCD	development operations coordination documents	IDs	identification numbers
		IHA	Incidental Harassment Authorization
DO&G	Div. of Oil and Gas (State)		
DPP	Development and Production Plan	in	inch(es)
DWM	Department of Wildlife Management (North Slope Borough)	in ³	cubic inch(es)
		IPCC	Intergovernmental Panel on Climate Change
E	evapotranspiration	I/SS	Ice/Sea Segment(s)
EA	Environmental Assessment	ISC	Ice Seal Commission
EEZ	U.S. Exclusive Economic Zone	ITL	Information to Lessees
EFH	Essential Fish Habitat	ITM	Information Transfer Meeting
EIS	Environmental Impact Statement	ITTC	Inupiat Teens Taking Control
EJ	Environmental Justice	IUCN/SSG	World Conservation Union/Species Survival Group
ENP	Eastern North Pacific stock of gray whales	IV	intravenous
EO	Executive Order	IWC	International Whaling Commission
E&P	Exploration and Production	kg	kilogram(s)
EP	Exploration Plan	kHz	kilohertz
EPA	Environmental Protection Agency	km	kilometer(s)
ERA	environmental resource area(s)	km ³	cubic kilometers
ERAP	Emergency Response Action Plan	kn	knot(s)
ERL	Effects Range-Low	kPa	kiloPascal(s)
ERM	Effects Range-Median	KyBP	thousand years Before Present
ESA	Endangered Species Act	L	liter(s)
ESI	Environmental Sensitivity Index	lat.	latitude
ESP	Environmental Studies Program	lb	pound(s)
EVOS	<i>Exxon Valdez</i> oil spill	LBCHA	Ledyard Bay Critical Habitat Area
EWC	(Alaska) Eskimo Walrus Commission	LC ₅₀	96-hour lethal concentration for 50% of test organisms
FAS	fetal alcohol syndrome	LHW	Lower Halocine Water
FDA	Food and Drug Administration	LME	large marine ecosystems
FLIR	forward looking infrared (videotape images)	LMR	Land Management Regulation
		LMW	low-molecular-weight (hydrocarbons)
FMP	Fishery Management Plan	LNG	liquefied natural gas
FNOS	Final Notice of Sale	LOA	Letter of Authorization
FOSC	Federal On-Scene Coordinator	long.	longitude
FR	<i>Federal Register</i>	LOSC	Local On-Scene Coordinator
FSB	Federal Subsistence Board	LS	land segment(s)
ft	foot/feet		

Acronyms

m	meter(s)	NSBCMP	North Slope Borough Coastal Management Plan
m/sec.	meter(s) per second	NSBMC	North Slope Borough Municipal Code
m ³ /sec.	cubic meter(s) per second	NSF	National Science Foundation
MAD	Mutual Aid Agreement	NTL	Notice to Lessees
Mcf	million cubic feet	NWAB	Northwest Arctic Borough
mg/kg	milligram(s)/kilogram(s)	O ₃	ozone
mg/L	milligram(s) per liter	OBC	ocean-bottom cable
mi	mile(s)	OCD	Offshore and Coastal Dispersion
mi ²	square mile(s)	OCS	Outer Continental Shelf
mL	milliliter(s)	OPA	Oil Pollution Act of 1990
mm	millimeter(s)	OSCP	Oil-Spill-Contingency Plan
MMbbl	million barrels (of oil)	OSRA	Oil-Spill-Risk Analysis (model)
MMC	Marine Mammal Commission	OSRO	oil-spill removal organization
MMcf	million cubic feet	OSRP	oil-spill-response plan
MMO	marine mammal observer	OSRV	Oil Spill Response Vessel
MMPA	Marine Mammals Protection Act	OWM	Oil Weathering Model
MMS	Minerals Management Service	P	precipitation
MOU	Memorandum of Understanding	PAC	powdered activated carbon
mph	miles per hour	PAH	polyaromatic hydrocarbons or polynuclear aromatic hydrocarbons (water quality)
MRSA	antibiotic-resistant staph infections	PAH	polycyclic aromatic hydrocarbons (fish resources, lower trophic-level organisms)
ms	millisecond(s)	PBR	potential biological removal
MSA	Magnuson-Stevens Fishery Conservation and Management Act	PBSG	Polar Bear Specialist Group
MyBP	million years Before Present	PCBs	polychlorinated biphenyls
NAAQS	National Ambient Air Quality Standards	PCH	Porcupine Caribou Herd
NAO	Arctic and North Atlantic Oscillations	PDO	Pacific Decadal Oscillation
NC	Nanuk Commission	PHBA	Public Health Baseline Assessment
NCP	National Contingency Plan	P.L.	Public Law
ng/g	nanogram(s) per gram(s)	PBR	potential biological removal
ng/L	nanogram(s) per liter	PBSG	Polar Bear Specialist Group
NGO	non-Government Organization(s)	PEA	Programmatic Environmental Assessment
NRC	National Research Council	PHN	Public Health Nursing
NEPA	National Environmental Policy Act	PM _{2.5}	fine particulates less than 2.5 microns in diameter
NISA	National Invasive Species Act of 1996	PM ₁₀	particulate matter less than 10 microns in diameter
nmi	nautical mile(s)	PNOS	Proposed Notice of Sale
NMFS	National Marine Fisheries Service	POPs	persistent organic pollutants
NO ₂	nitrogen dioxide	ppb	parts per billion
NO _x	nitrous oxide	ppm	parts per million
NOI	Notice of Intent to Prepare an EIS	ppt	parts per thousand
NORM	Naturally Occurring Radioactive Materials	PREP	Preparedness for Response Program
NPDES	National Pollution Discharge Elimination System	PSD	Prevention of Significant Deterioration
NPFMC	North Pacific Fisheries Management Council	PTS	Permanent Threshold Shift
NPR-A	National Petroleum Reserve - Alaska	RCRA	Resource Conservation and Recovery Act
NPR-4	Naval Petroleum Reserve No. 4	rms	root-mean-square
NRC	National Research Council	ROD	Record of Decision
NRDC	National Resources Defense Council		
NSB	North Slope Borough		

Acronyms

ROI	rate of increase (in whale population)	UC	Unified Command
ROP	Required Operating Procedure	U.S.C.	United States Code
RRT	Regional Response Team	USCG	United States Coast Guard
RS/FO	Regional Supervisor/Field Operations	USDA	United States Department of Agriculture
SAC	Scientific Advisory Committee	USDOJ	United States Department of the Interior
SAP4.6	Synthesis and Assessment Product 4.6	USGS	United States Geological Survey
sBSW	summer Bering Sea Water	USSR	United Soviet Socialist Republics
SBS	Southern Beaufort Sea (population of polar bears)	UV	ultraviolet
SCAT	Shoreline Cleanup Assessment Team	VOCs	volatile organic compounds
SCC	Siberian Coastal Current	VSMs	vertical support members
SDH	social determinants of health	WAH	Western Arctic Caribou Herd
SDI	South Drilling Island	wBSW	winter Bering Sea Water
sec	second(s)	WHB	Western Hudson Bay
SEL	sound-exposure level	WHO	World Health Organization
SLiCA	Survey of Living Conditions in the Arctic	WIC	Women, Infants, and Children (program)
SO ₂	sulfur dioxide	Y-K Delta	Yukon-Kuskokwim Delta
SOI	Shell Offshore, Inc.	yd	yard(s)
SOSC	State On-Scene Coordinator	yd ³	cubic yard(s)
SPL	sound-pressure level	2D	2-dimensional (seismic survey)
SPM	suspended-particulate matter	3D	3-dimensional (seismic survey)
SSDC	single steel drilling caisson	°C	degrees Celsius
Sv	Sverdrup(s)	°F	degrees Fahrenheit
SWZ	Subsistence Whaling Zone	<	less than
TAGS	Trans-Alaska Gas System	>	greater than
TAPS	Trans-Alaska Pipeline System	≥	greater than or equal to
TB	tuberculosis	μg	microgram(s)
Tcf	trillion cubic feet (of gas)	μg/g	microgram(s) per gram
TCH	Teshkepuk Lake Caribou Herd	μg/kg	microgram(s) per kilogram
Tg	teragrams	μg/m ³	microgram(s) per cubic meter
TLSA	Teshkepuk Lake Special Area	μg/L	microgram(s) per liter
TLSUA	Teshkepuk Lake Special Use Area	μPa	microPascal(s)
TSS	total suspended solids	~	about
TTS	Temporary Threshold Shift	§	section

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4-610	4.4.4.14. Archaeological Resources
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4-610	4.4.4.15. Environmental Justice
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	4.4.6.5.2. Mitigation Measures
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4-627	4.4.6.6. Threatened and Endangered Species
	4.4.6.6.1. Threatened and Endangered Whales
	4.4.6.6.1.1. Potential Effects to Threatened and Endangered Whales
	4.4.6.6.1.2. Mitigation Measures
	4.4.6.6.1.3. Anticipated Effects Under Alternative 6
	4.4.6.6.1.3.1. Direct and Indirect Effects Under Alternative 6
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4-630	4.4.6.7. Marine and Coastal Birds
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	4.4.6.9.3. Anticipated Effects Under Alternative 6
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4-633	4.4.6.10. Vegetation and Wetlands
4-633	4.4.6.11. Economy
4-633	4.4.6.12. Subsistence-Harvest Patterns and Resources
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4-634	4.4.6.14. Archaeological Resources
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4-634	4.4.6.15. Environmental Justice
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4.4. Effects Assessments for Beaufort Sea Sales 209 and 217.

4.4.1. Alternative 1, Beaufort Sea - No Lease Sale.

Under this alternative (no-action alternative), a proposed Beaufort Sea OCS lease sale, as scheduled in the 2007-2012 5-Year Program, would not be approved.

The cumulative effects analyses below evaluate the past, present, and reasonably foreseeable activities to environmental and sociocultural resources in the Beaufort Sea areas, without any of the proposed actions or alternatives. The analysis includes effects from Federal, State, and local activities, both offshore and onshore activities and both oil and gas-related and non-oil and gas related. The cumulative analysis includes consideration of the influence of dynamic climate and anticipated change in the environment. The effects are addressed quantitatively to the degree possible, using known types, levels, and trends of both oil and gas activities and non-oil and gas activities. Impacts that cannot be estimated quantitatively are described qualitatively.

The analysis below does not include the incremental effects of any of the alternatives, and so presents the cumulative effects that are reasonably likely to occur whether or not a lease sale analyzed in this EIS is held. In the cumulative analyses under the action alternatives (Alternatives 2-6), the incremental effects of the each alternative are evaluated. The potential difference in anticipated level of cumulative effects to environmental resources under each action alternative is then compared to anticipated level of effects in the cumulative analysis below.

4.4.1.1. Water Quality.

Summary. There would be no direct or indirect impacts to water quality from Alternative 1. There would be no incremental contribution to cumulative effects from Alternative 1.

Water quality in the Beaufort Sea will be impacted by a number of ongoing and future activities and events, regardless of any decisions made about proposed Beaufort Sea Sales 209 and 217. This section describes the impacts of reasonably foreseeable future events such as those detailed in Section 4.2, including: construction activities on the North Slope and elsewhere on the coast, pollution, climate change, and offshore operations resulting from previous sales in the Beaufort Sea.

Effects Definitions and Levels. The impact levels used throughout this analysis are based on the four-level classification scheme for biological and physical resources outlined in the Cape Wind Energy Project Draft EIS (USDOJ, MMS, 2008a). These four impact levels are defined as follows:

- **Negligible** - No measurable impacts.
- **Minor** - Most impacts to the affected resource could be avoided with proper mitigation, or if impacts occur, the affected resource would recover completely without any mitigation once the impacting agent is eliminated.
- **Moderate** - Impacts to the affected resource are unavoidable; the viability of the affected resource is not threatened although some impacts may be irreversible; or the affected resource would recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.
- **Major** - Impacts to the affected resource are unavoidable; the viability of the affected resource may be threatened; and the affected resource would not fully recover even if proper mitigation is applied during the life of the proposed action or remedial action is taken once the impacting agent is eliminated.

Cumulative Effects Under Alternative 1. The construction of roads, pads and other infrastructure associated with the maintenance and development of oil and gas activity on the North Slope and community development projects, such as the proposed Barter Island airport relocation, can cause adverse effects on water quality. The vegetation typically is cleared from an area in preparation for construction, leading to greater erosion and runoff from the site. Increased amounts of contaminants such as particulate matter, heavy metals, petroleum products, and chemicals are then transported to local streams, estuaries, and bays. Dredging operations to provide gravel for construction projects or to create trenches for pipelines also have detrimental effects on water quality. Dredging disturbs the seafloor, increasing suspended sediment in the water column. The amount of turbidity and size of the plumes would depend on a number of factors, including season and sediment-grain size. The impacts of these activities would be minor, local, and temporary.

Pollution from coastal communities and transportation activities also impacts water quality in the Beaufort Sea. Runoff and disposal of municipal waste can result in increased levels of suspended solids and other pollutants in the water column. These activities could have minor effects in localized areas, but regional effects will be negligible due to dilution.

Vessel traffic contributes to the degradation of water quality through oily discharges, dumping of bilge water, treated sanitary and other wastes, and the leaching of contaminants from antifouling paints, as well as possible increases in turbidity in some areas. Since 1973, discharges incidental to the normal operation of vessels have been excluded from NPDES permitting requirements. A recent court order has revoked 40 CFR § 122.3(a), the regulation excluding these discharges, effective December 19, 2008. Current U.S. Coast Guard regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water are found at 33 CFR § 151.

Airborne pollutants deposited directly on the sea surface or deposited on land and carried to the ocean through runoff further can reduce water quality. Contaminants of interest, which can be transported over very long distances in the atmosphere, include nitrogen and sulfur compounds; persistent organic pollutants (POPs), such as pesticides, polychlorinated biphenyls (PCBs), and PAHs; and trace metals including chromium, arsenic, cadmium, mercury, selenium, copper, zinc, vanadium, and barium (AMAP, 1997; Hanson, 2003).

These contaminants are of particular concern in the Arctic because of the colder temperatures, which allow them to persist in the environment and resist degradation. Though the atmospheric deposition rates of these pollutants in the Arctic is quite low (Gubala et al., 1995), even very low concentrations can cause serious impacts on biological resources, because they accumulate in the tissues of organisms and become magnified as they move through the food chain. Spies et al. (2003) found evidence of bioaccumulation of these contaminants in five species of fish in the Beaufort Sea. The effects of atmospheric deposition of pollutants on water quality are minor, though impacts on biological resources could be more severe.

As noted in Section 3.2.5.2, water quality can be affected by climate change mechanisms such as loss of sea ice and changing weather patterns. In addition, climate change can lead to altered water chemistry, including acidification and reduced levels of dissolved oxygen. Increased vessel traffic is also a likely consequence of the loss of sea ice and extended period of open water. Because the magnitudes of the changes in climate are not well known, the severity and extent of the effects on water quality cannot be fully predicted, though the water quality changes would be expected to lead to severe impacts on biological resources. A comprehensive discussion of the effects of climate change is beyond the scope of this document, but water quality would be expected to completely recover if the climate change were reversed.

The potential impacts on water quality of current and reasonably foreseeable offshore operations, including construction activities and permitted discharges, resulting from previous sales in the Beaufort Sea have been described in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a) and the 2007-2012 5-Year EIS (USDOJ, MMS, 2007c). These assessments concluded that permitted activities would have minor effects on local water quality, and negligible effects on regional water quality. Increases in turbidity from permitted construction and dredging activities would be temporary, but the effects of permitted discharges would last over the life of the fields. The adverse effects from most oil spills also would be local and temporary, but frequent small spills could result in local, chronic contamination.

Under Section 402 of the CWA, the EPA or authorized States can issue permits for pollutant discharges, or they can refuse to issue such permits if the discharge would create conditions that violate the water-quality standards developed under Section 303 (33 U.S.C. § 1313) of the CWA. The CWA, Section 403 (33 U.S.C. § 1343), also states that no NPDES permit shall be issued for a discharge into marine waters except in compliance with established guidelines.

The general NPDES permit AKG280000 (EPA, 2006b) for the offshore areas of Alaska located in the Beaufort Sea, Chukchi Sea, Hope Basin, and Norton Basin authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths and areas of operation, and has monitoring requirements and other conditions. This permit does not apply to development and production facilities, which require individual permits. There are no individual NPDES permits for offshore oil and gas facilities in the Beaufort Sea currently in effect as of October 2008.

Applicable ambient-water quality standards for marine waters of the State of Alaska are (1) total aqueous hydrocarbons in the water column may not exceed 15 µg /L (15 parts per billion [ppb]); (2) total aromatic hydrocarbons in the water column may not exceed 10 µg /L (10 ppb) and (3) surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration (ADEC, 2006). The State of Alaska criterion of a maximum of 15 ppb of total aqueous hydrocarbons in marine waters—about 15 times background concentrations—provides the readiest comparison and is used in this discussion of water quality. This analysis considers 15 ppb to be a chronic criterion and 1,500 ppb—a hundredfold higher level—to be an acute criterion. Hydrocarbons from a large oil spill could exceed the 1,500 ppb acute toxic criterion during the first day of a spill and the 15 ppb chronic criterion for up to a month in an area the size of a small bay.

Conclusion. The level of impact on water quality in the Beaufort Sea from the combined effects of past, present, and reasonably foreseeable activities without the proposed Beaufort Sea lease sales, with consideration of climate change, would be minor to moderate.

4.4.1.2. Air Quality.

Summary. There would be no direct or indirect impacts to air quality from Alternative 1. There would be no incremental contribution to cumulative effects from Alternative 1.

Effects Definitions and Levels. Major new emission sources (with potential emissions greater than 250 tons per year) are required to meet the PSD Class II incremental limits for NO₂, SO₂ and PM₁₀.

Cumulative Effects Under Alternative 1. This section describes impacts that would occur even if the proposed Beaufort Sea Sales 209 and 217 were not held. Air emissions still would result from power generation, home heating, motor vehicles, aircraft, and vessels. These emissions have only a very small effect on ambient air quality. On the whole, these activities are not expected to change significantly in the future. There likely would be an increase in vessel activity due to a decrease in sea ice resulting from

climate change, but the more stringent standards on marine engines being implemented by EPA should mitigate any potential increases in emissions.

The largest source of air emissions would continue to be from oil and gas production activities on the North Slope (Prudhoe Bay, Kuparuk, Milne Point, Badami, and Alpine units) and in State waters (Northstar and Duck Island units). A large majority of the emissions are in the form of nitrogen oxides (NO_x); other pollutants include particulate matter less than 10 micrograms in size (PM₁₀), sulfur dioxide (SO₂), and volatile organic compounds (VOC). The emissions impact the ambient air quality around these production areas, but monitoring in the vicinity of some of the production centers has demonstrated that concentrations are well within the National Ambient Air Quality Standards (NAAQS). While production from the older fields is in decline, new production has started from existing leases and new oil development may result from future State leases and Federal lease sales in the National Petroleum Reserve-Alaska (NPR-A). Should any natural gas production occur in the future, there may be air emissions from any related gas processing. There also will be local sources of gaseous emissions and fugitive dust from construction and maintenance activities associated with both existing and new facilities.

Major new emission sources (with potential emissions greater than 250 tons per year) are required to meet the PSD Class II incremental limits for NO₂, SO₂ and PM₁₀. Modeling studies of proposed OCS production facilities in the Beaufort Sea show that concentrations of nitrogen dioxide (NO₂), SO₂, and PM₁₀ are within the Prevention of Significant Deterioration (PSD) incremental limits and the NAAQS with the highest concentrations of NO₂, SO₂, and PM₁₀ occurring within about 200 m of the facility and considerably reduced values at distances greater than 1 km (USDOJ, MMS, 2001a). Therefore, there would be little cumulative interaction between facilities that are spaced some distance apart.

Air quality effects from routine air emissions are not expected to change significantly in the future, and impacts will continue to be minor.

Small accidental oil spills on land or on the water would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would be expected to occur within a few hours of the spill and decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on air quality is presented in Section 4.4.2.2.3.

In-situ burning of an oil spill would result in a visible plume and a localized increase in PM_{2.5} concentrations. A discussion of the effects of in-situ burning is presented in Section 4.4.2.2.3. Studies of in-situ burn experiments have shown that air quality impacts are localized and short lived, and that pollutant concentrations do not pose a health hazard to persons in the vicinity.

Conclusion. Routine emissions from ongoing and future activities without the proposed Beaufort Sea lease sales would result in ambient air quality levels that are within applicable standards. Air quality would not change significantly from existing levels. Air quality impacts would be minor. Air quality impacts from oil spills would be localized and of short duration.

4.4.1.3. Lower Trophic-Level Organisms.

Summary. There would be no direct or indirect impacts to lower trophic-level organisms from Alternative 1. There would be no incremental contribution to cumulative effects from Alternative 1.

Cumulative Effects Under Alternative 1. The most recent assessment of Beaufort offshore operations on lower trophic-level organisms was in the Beaufort Sea Multiple-sale EIS (USDOJ, MMS, 2003a:Section IV.C.2). The assessment explained that resource-development activities could affect lower trophic-level organisms (phytoplankton, zooplankton, epontic algae {or epontic-dependent species} and benthos) by exposing them to drilling discharges, seismic surveys, construction, and petroleum-based hydrocarbons. In general, effects associated with the low and high ends of the resource-recovery range likely would be similar in most cases (one large oil spill was evaluated for both). Drilling discharges are estimated to affect less than 1% of the benthic organisms in the sale area and none of its plankton. Affected benthic organisms likely would experience sublethal effects, but some (mostly immature stages) would be killed. Recovery likely would occur within 1 year after the discharge ceases. Seismic surveys likely would have little or no effect on lower trophic-level organisms. Construction likely would have little or no effect on plankton communities. Less than 1% of the immobile benthic organisms would be affected by construction (mostly sublethal effects). Immobile benthic communities affected by pipeline construction likely would recover in less than 3 years. Marine organisms needing a hard substrate for settlement likely would benefit from the production platforms (particularly those associated with the high end of the resource-recovery range) and to colonize them within 2 years.

The assessment noted specifically that several studies have found that sunlight makes some hydrocarbon components more toxic. One study showed that marine invertebrates are affected more by polycyclic aromatic hydrocarbons under ultraviolet radiation. The authors noted that ultraviolet radiation would not penetrate turbid coastal water. These results were corroborated by another study (Shirley and Duesterloh, 2002); they observed increased oil toxicity to subsurface copepods in the presence of ultraviolet radiation.

A large oil spill was estimated to have sublethal and lethal effects on less than 1% of the plankton in the coastal band of high concentration. Recovery likely would require a couple of days for phytoplankton and up to a week for zooplankton. Recovery within the affected embayments likely would require a couple of weeks. During a winter oil spill, if oil were trapped under the ice, epontic organisms living there probably would be killed. Less than 5% of the epontic community in the sale area likely would be affected this way. Although crude oil probably would not mix down into the water column and affect benthic organisms, spills of refined petroleum such as diesel fuel could be mixed deeper into the water column, potentially affecting kelp communities. The OSRA model estimates for summer that the chance of contact with the shoreline would be low, and that the chance of contact to the ANWR coastline specifically would be highest for any inshore spill in the eastern Alaskan Beaufort Sea. If a large spill did contact the shoreline, small amounts of the spilled oil would probably affect the shoreline for more than a decade in spite of cleanup responses.

The assessment summarized that lower trophic-level organisms would be affected by discharges, disturbances, and spills. Permitted drilling discharges probably would affect benthic organisms within 1,000 m (3,300 ft) of the discharge points, and recovery likely would occur within a year. Platform and pipeline construction is estimated to adversely affect less than 1% of the immobile benthic organisms in the sale area, and recovery likely would occur within 3 years. Special kelp communities could be protected from construction effects by required benthic surveys. In the unlikely event that a large oil spill occurs, it is estimated to affect only a small portion of the planktonic and/or epontic organisms in the sale area. Recovery of plankton likely would occur within a week (2 weeks in embayments). Spills of refined petroleum in relatively shallow water could affect the benthos, including kelp communities. The OSRA model estimates the chance of contact to the coastline is low, and that the chance of contact to the coastline of the Arctic National Wildlife Refuge specifically would be highest for any inshore spill in the eastern Alaskan Beaufort Sea. If a spill did contact the shoreline, a small amount of spilled oil probably would persist in sediments for more than a decade. Spill responses would reduce some of the effects. Responses could recover most of any spilled oil on a solid-ice cover and some of any oil in open water, reducing the effects on lower trophic-level organisms; but oil in broken ice would be difficult to recover.

Spill responses to oil on the shoreline probably would affect the habitat as much as the oil itself. The Boulder Patch is one of the specified biological resources to be considered in contingency plans. Overall, the level of mitigated effects within the Beaufort lease area would be minor.

The cumulative effects of all previous lease sales are summarized in Section 3.3.1.1. The effects to date appear to be due partly to the effect of approved discharges such as construction fill, slope-protection fabric, and drilling muds/cuttings in water more than 20 m (65 ft) deep. As noted, extensive seafloor monitoring has documented some interannual changes in sediment chemistry and the Boulder Patch kelp community (Dunton, 2005). Boulder Patch monitoring has demonstrated that suspended sediment concentrations substantially affect light availability and kelp production during the summer open-water period. However, most of the changes in suspended sediment concentrations have been related to the broad-scale changes in the ice cover and coastal erosion (Section 3.2.4.3).

Conclusion. The cumulative level of effects on lower trophic-level organisms would be minor.

4.4.1.4. Fish Resources.

Summary. We determined that there would be no direct or indirect effects to fish resources if the lease sales were not held. Marine and coastal areas of the North Slope are commonly perceived to be pristine environments, yet there are number of past actions and ongoing activities that are sources or are potential sources of harmful effects to fish resources. Existing impacts to fish resources from underwater noise and habitat loss are anticipated to continue to at no more than a minor level of effect. Existing State and Federal leases in the project area would continue to be explored with seismic survey and possibly, exploratory drilling, as well as other ancillary activities. Oil resources could be developed, although this is considered speculative. Spills, particularly in nearshore areas or at river crossings, pose a risk to fish resources. Oil spills from marine vessels or the oil and gas industry are considered high effect, low likelihood events. Transfer of bulk fuel to coastal communities poses the greatest risk of a large noncrude oil spill in the marine environment.

The changing climate could positively or negatively affect the distribution or abundance of numerous marine and freshwater species. Continuing climate change will lead to the loss or alteration of habitats important to fish resources and to changes in biological communities. Changes in the physical environment also may serve to promote increased vessel traffic in the Arctic, especially in the form of tourism or cargo shipping, thereby increasing the chance of vessel accidents, groundings, and spills. Alternative 1 is anticipated to result in a minor cumulative level of effect on fish resources in the Proposed Action area, with the exception of changes in the physical environment, which could have a major level of effect on fish resources.

In the following analysis we describe the potential effects from a variety of existing sources on fish resources. We then describe mitigation measures that would help to avoid or minimize some of the negative effects (Section 4.4.1.4.2). The anticipated effects on fish resources are then described in Section 4.4.1.4.3.

4.4.1.4.1. Potential Effects to Fish Resources. The principal existing sources of potential effects to fish resources in the Beaufort and Chukchi seas include: (1) underwater noise; (2) habitat loss; (3) community and industrial development (4) petroleum spills; and (5) changes in the physical environment.

4.4.1.4.1.1. Potential Effects from Underwater Noise. In this section we describe the general hearing abilities and other sensory capabilities of fish and then describe how vessel noise (Section 4.4.1.4.1.1.1), seismic survey noise (Section 4.4.1.4.1.1.2), and oil and gas exploration and production

noise (Section 4.4.1.4.1.1.3) can affect the physiology (Section 4.4.1.4.1.1.4) and behavior (Section 4.4.1.4.1.1.5) of fishes in the Beaufort and Chukchi seas.

Acoustic Detection and Other Sensory Capabilities of Fish. Marine organisms have evolved in many ways to sense their environment and use these senses to provide information that allows them to communicate and to find their way (Popper, 2003). Fish can detect sounds via the saccule of the ear (one of the inner ear end organs) (Popper et al., 2003). Studies have demonstrated that many fish species produce and use sounds for a variety of behaviors, with some discriminating between different frequencies and intensities, and detect the presence of a sound within substantial background noise (Popper et al., 2003). Fish use sounds in behaviors including aggression, defense, territorial advertisement, courtship, and mating (Popper et al., 2003). Hearing in fish is not only for acoustic communication and detection of sound-emitting predators and prey; it also can play a major role in telling fish about the acoustic scene at distances well beyond the range of vision (Popper et al., 2003).

Some teleost (bony fish) species can detect infrasound (sounds below 20 Hertz [Hz]). Juvenile salmonids display strong avoidance reactions to infrasound (Popper et al., 2003, citing Knudsen et al., 1992, 1997), and it is reasonable to suggest that such behavior has evolved as a protection against predators. Infrasound has been used as an effective acoustic barrier for downstream migrating Atlantic salmon (*Salmo salar*) smolts (Popper et al., 2003, citing Knudsen et al., 1994).

There probably is no other sensory system as specialized for sensory processing in the aquatic environment as the lateral-line system (Coombs and Braun, 2003). It is a water-current detector found exclusively in certain fish and some amphibians. The lateral-line system generally is a close-range system, capable of detecting current-generating sources (e.g., nearby swimming fishes) no more than one or two body lengths away. The lateral-line system also can detect ambient water motions, such as those in a stream or ocean current, as well as distortions in ambient or self-generated motions due to the presence of stationary objects, such as rocks or boulders. As such, the lateral-line system is believed to influence a number of different behaviors, including schooling, prey capture, courtship and spawning, and movements within a current (rheotaxis). In a more general sense, the lateral-line system undoubtedly also is used to form hydrodynamic images of the environment, enabling fishes to determine the size, shape, identity, and location of both animate and inanimate entities in their immediate vicinity.

Evidence suggests that the lateral line serves as a pressure gradient and particle-motion sensor enabling schooling fish to mediate their proximity and velocity within the body of their school (Stocker, 2002, citing Cahn, 1970, Partridge and Pitcher, 1980). Stocker (2002) suggests that a school of fish could be modeled as a low-frequency oscillating body that the individual fish synchronize to. This view is supported by the visual presentation of fish schools in sunlight that sometimes appear to “flash” simultaneously as they respond to disturbances. This is substantiated also by evidence that when startled by airgun noise, schooling fish fall out of rank and take time to reassemble (Stocker, 2002, citing McCauley et al., 2000b). The startle response involves establishing a tighter grouping, so the observed response is not believed to be a scatter response. The interruption or startle response observed in the airgun study might indicate that the hearing of individual fishes is momentarily compromised, or the pressure-gradient field of the school is disturbed sufficiently to lose its integrity and takes time to reestablish, or perhaps some combination of both.

4.4.1.4.1.1.1. Vessel Noise. Engine-powered vessels may radiate considerable levels of noise underwater. Diesel engines, generators, and propulsion motors contribute significantly to the low-frequency spectrum. Much of the necessary machinery to drive and operate a ship produces vibration, within the frequency range of 10 Hz-1.5 kilohertz (kHz), with the consequence of radiation in the form of pressure waves from the hull (Mitson and Knudsen, 2003). In addition to broadband propeller noise,

there is a phenomenon known as “singing,” where a discrete tone is produced by the propeller, usually due to physical excitation of the trailing edges of the blades. This can result in very high tone levels within the frequency range of fish hearing. The overall noise of a vessel may emanate from many machinery sources. Pumps in particular often are significant producers of noise from vibration and, at higher frequencies, from turbulent flow. Sharp angles and high flow rates in pipe work also can cause cavitation, and even small items of machinery might produce quite high levels of noise.

Mitson and Knudsen (2003) examined the causes and effects of fisheries research-vessel noise on fish abundance estimation and noted that avoidance behavior by a herring school was shown due to a noisy vessel; by contrast, there is an example of no reaction of herring to a noise-reduced vessel. They note a study wherein the FRV *Johan Hjort* was using a propeller shaft speed of 125 revolutions per minute, giving a radiated noise level sufficient to cause fish avoidance behavior at 560 m distance when traveling at 9 knots (kn), but it reduced to 355 m at 10 kn. Mitson and Knudsen (2003, Figure 5) showed that large changes in noise level occur for a small change in speed. Their data also suggest abnormal fish activity continues for some time as the vessel travels away from the recording buoy used in the study.

Vessel traffic is chiefly during ice-free conditions. Vessel traffic may disturb some fish resources and their habitat during operations. Pacific salmon in the coastal and marine environment may be disturbed by vessel-traffic noise. However, vessel noise is expected to be chiefly transient; fishes in the immediate vicinity of such vessels are believed likely to avoid such noise perhaps by as much as several hundred meters. Vessel traffic is expected to increase in the Chukchi and Beaufort seas (Section 4.3).

4.4.1.4.1.1.2. Seismic-Survey Noise. The following information is largely an abridged version of a more detailed description of the potential effects of seismic surveys evaluated for the seismic-survey Programmatic EA and the Sale 193 draft EIS (USDOL, MMS 2006a,g). The principle impacting agent attributable to seismic surveys involves the acoustic-energy pulses emitted by airguns. This section evaluates the acoustic impacts associated with airgun noise. Vessel noise was addressed in the previous section. Mechanical impacts to habitat (i.e., via anchoring, cable towing, OBC deployment and retrieval from the seafloor, and cable hangups) are addressed in Section 4.4.1.4.1.2).

Fishes of greatest concern, due to their distribution, abundance, trophic relationships, or vulnerability, are: (1) the diadromous fishes that are abundant seasonally in the nearshore zone, especially Dolly Varden char, least cisco, and broad whitefish; (2) cryopelagic fishes such as the arctic cod, an abundant and trophically important fish; (3) intertidal, estuarine, or nearshore spawning and/or rearing fishes (e.g., capelin and Pacific herring); and (4) Pacific salmon. Some of these species also are important because they figure prominently in subsistence (e.g., Dolly Varden char, cisco, whitefish, arctic cod, rainbow smelt, capelin, and salmon).

In general, marine fish likely can hear seismic airgun emissions, especially for hearing generalists (e.g., flatfish) and specialists (e.g., herring). The frequency spectra of seismic-survey devices cover the range of frequencies detected by most fish (Pearson, Skalski, and Malme, 1992; Platt and Popper, 1981; Hawkins, 1981). Marine fishes are likely to detect airgun emissions nearly 2.7-63 km (1.6-39 mi) from their source, depending on water depth (Pearson, Skalski, and Malme, 1992). Pearson, Skalski, and Malme (1992) reported fish responses to seismic sources are species specific.

4.4.1.4.1.1.3. Oil and Gas Exploration or Production Noise. Underwater noise is produced during exploratory and production drilling. Drilling rigs (on two ice-bound gravel islands) produced noise (<200 Hz) that was recorded under sea ice out to a distance of 1.5 km. Moored drillship noise is predicted to attenuate to 115-120 dB at distances of 1-10 km. If fishes were disturbed by underwater

noise emitted from the drill rigs, similar to reactions described in Section 4.4.1.4.1.1.2, fish could move away from the source of the noise, effectively being displaced from a zone around the drill rig.

Noise-related disturbance effects to fish and direct loss or degradation of fish habitats likely would occur during construction in the marine environment (e.g., well sites, platform placement, pipeline trenching/burial) and at freshwater sites (pipeline and maintenance road construction). Noise also is produced by vessels servicing exploration rigs and production platforms. Effects from these activities would be similar to those described in Section 4.4.1.4.1.1.2. This vessel activity would be infrequent and be generally restricted to an area between the drill site and a land-based support site.

4.4.1.4.1.1.4. Physiological Effects. Seismic-survey acoustic-energy sources may damage or kill eggs, larvae, and fry of some fishes occurring in close proximity to an airgun, but the harm generally is limited to within 5 m (15 ft) from the airgun and greatest within 1 m (3 ft) of the airgun (e.g., Kostyuchenko, 1973; Dalen and Knutsen, 1987; Holliday et al., 1986; Turnpenny and Nedwell, 1994). Airguns are unlikely to cause immediate deaths of adult and juvenile marine fishes. Sound sources that have resulted in documented physiological damage and mortality of adult, juvenile, and larval fish all have been at or above 180 dB re 1 microPascal (180 dB re 1 μ Pa) (Turnpenny and Nedwell, 1994). The likelihood of physical damage is related to the characteristics of the sound wave, the species involved, life stage, distance from the airgun array, configuration of array, and the environmental conditions.

The Canadian Department of Fisheries and Oceans (CDFO, 2004) reviewed scientific information on impacts of seismic sound on fish and concluded that exposure to seismic sound is considered unlikely to result in direct fish or invertebrate mortality. Damage to fish from seismic emissions may develop slowly after exposure (Hastings et al., 1996). Table 1 of Turnpenny and Nedwell (1994) lists observed injuries (for fishes: adult, juvenile, larvae, and eggs) caused by exposure to high-level sound sources.

Overall, the available scientific and management literature suggests that mortality of juvenile and adult fish, the age-classes most relevant to future reproductive fitness and growth, likely would not result from seismic-survey activity. Fishes with impaired hearing may have reduced fitness, potentially making them vulnerable to predators, possibly unable to locate prey or mates, sense their acoustic environment or, in the case of vocal fishes, unable to communicate with other fishes.

4.4.1.4.1.1.5. Behavioral Effects. The most likely impacts to marine fish and invertebrates from seismic activity would be behavioral disruptions. Behavioral changes to marine fish and invertebrates from seismic-survey activity have been noted in several studies (e.g., Dalen and Knutsen, 1987; McCauley et al., 2000; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992), including:

- balance problems (but recovery within minutes);
- disoriented swimming behavior;
- increased swimming speed;
- tightening schools;
- displacement;
- interruption of important biological behaviors (e.g., feeding, mating);
- shifts in the vertical distribution (either up or down); and
- occurrence of alarm and startle responses (generally around 180 dB re 1 μ Pa and above).

Behavioral impacts are most likely to occur in the 160- to 200-dB range (Turnpenny and Nedwell, 1994).

These responses are expected to be species specific. Displacement also may be relative to the biology and ecology of species involved. Available studies have indicated that these reactions are likely to be short

term in nature. Although repeated, short-term disturbances can result in long-term impacts, seismic activity typically would be limited to the open-water season within discrete areas and, therefore, the timeframe is limited in scope.

Fish distribution and feeding behavior can be affected by the sound emitted from airguns and airgun arrays (Turnpenny and Nedwell, 1994). Pelagic fish-catch rates and local abundance were reduced within 33 km of the airgun array for at least 5 days after shooting (Engås et al. 1993, 1996). There is no conclusive evidence for long-term or permanent horizontal displacement, and vertical displacement may be the short-term behavioral response (Slotte et al., 2004). Normal fish behavior likely returns when the airguns are turned off. The repopulation of the vacated area is reliant upon a diffusion like process (Turnpenny and Nedwell, 1994).

Seismic surveys potentially may disrupt feeding activity and displace diadromous and marine fishes (i.e., capelin, cisco, and the whitefishes) from critical summer feeding areas along the coast.

Migration, Spawning, and Survival Effects. Most important to this issue are behavioral reactions that could result in disruption of migratory pathways or diminishing the availability of fish resources as subsistence resources (e.g., through fish abandoning important fishing grounds). For coastwise migratory fish species, acoustic disturbance may displace and disrupt important migratory patterns, habitat use, and life-history behaviors. The populations of many species move from one habitat to another and back again repeatedly during their life (Begon, Harper, and Townsend, 1990). The time-scale involved may be hours, days, months, or years.

For wide-ranging, migratory fish species, disturbance and displacement may disrupt important migratory and life-history behaviors and patterns or habitat areas. Seismic surveys conducted in Federal waters close to State waters, where many fishes migrate through to spawning sites along the coast or in anadromous streams of the Arctic, may disrupt or impede their migrations as fishes attempt to avoid airgun emissions. In addition, conducting more than one seismic operation simultaneously may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors) and concentrating many fishes in areas of unsuitable use.

Migratory species at risk of brief spawning delays include Pacific herring, capelin, Pacific salmon (chiefly pinks and chums), cisco, broad whitefish, and Pacific sand lance. Pacific herring and arctic cod are hearing specialists and are most likely the most acoustically sensitive species occurring in the Sale 193 area. They are, therefore, the most likely to exhibit displacement and avoidance behaviors of the arctic fishes occurring in the Proposed Action area. Pacific salmon and the whitefish spawn in freshwater habitats of the Arctic coast. Pacific herring, capelin, and Pacific sand lance spawn on beaches or in nearshore waters.

The 3D/2D seismic surveys typically cover a relatively small area and only stay in a particular area for hours, thereby posing somewhat transient disturbances. Adverse effects to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized.

Effects from Coincidental, Multiple Seismic Surveys. Given the limited evidence of avoidance and displacement from survey areas, the interaction of coincident multiple surveys may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors, access to overwintering sites) and concentrating many fishes in areas of unsuitable use. Such areas may not include suitable prey species or

in densities to support the concentrated fishes. Displacement also may expose them to more predation than naturally experienced.

Concurrent seismic surveys may facilitate the stranding of some schooling or aggregated arctic fishes onto coastal or insular beaches in the Proposed Action area. Such strandings may be more likely if multiple seismic surveys were to spatially “box in” fishes along the shoreline and, thus, limit their avenues of retreat to less ensonified waters.

4.4.1.4.1.2. Potential Effects from Habitat Loss. Fish and fish habitats can be affected by a number of community, industry, and other activities. These include construction activities that have direct and indirect effects on freshwater and marine habitats, effects from drilling discharges, and effects from anchor or seismic cable deployment or recovery.

4.4.1.4.1.2.1. Community Development. Communities along the coast of the Beaufort and Chukchi seas are typically small, but often have projects that have adverse effects on freshwater habitats that support fishes. These include road, bridge, airport, residential development, and public and institutional projects. The extent of these developments and some recently proposed projects are described in Sections 3.1.2.1 (Infrastructure), 4.2.1.1 (Transportation and Infrastructure), and 4.4.1.6.2.3.2.7 or 4.4.1.7.3.2.7 (Habitat Loss). Additionally, these communities often draw freshwater from ponds and lakes that also support fishes.

4.4.1.4.1.2.2. Industrial Development. As with existing coastal communities, the expansion of existing oil and gas facilities and infrastructure continue to have adverse effects on freshwater habitats that support fishes. These include construction of additional roads, pipelines, and pads for storage and to otherwise support industrial activities. Support of these industrial facilities requires vast amounts of freshwater which can result in the drawdown of lakes. The drawdown of lakes can reduce the amount of fish habitats. Some lakes for water supplies are created by excavating freshwater wetlands. The extent of these developments and some recently proposed projects are described in Sections 3.1.2.1 (Infrastructure), 4.2.1.1 (Transportation and Infrastructure), and 4.4.1.6.2.3.2.7 or 4.4.1.7.3.2.7 (Habitat Loss). Similar projects continue to be proposed on a regular basis (see U.S. Army Corps of Engineers Public Notices posted at <http://www.poa.usace.army.mil/reg/PNnew.htm>).

Exploration wells could result in a temporary, direct loss of seafloor habitats at the placement site, but these sites are relatively small compared to the amount of similar habitats available in the marine environment.

Once seismic surveys have indicated a potential source of oil, companies would delineate the field with exploratory wells. Once the field is defined and further evaluated, a production platform may be constructed to collect oil from wells around the platform.

If another commercial discovery is made from existing federal leases in the Beaufort Sea, there could be construction of a production well/platform/facility footprint and new pipelines to the existing product transportation infrastructure. Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <50 m (~165ft). Trenching and pipe laying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, would remain for short-amounts of time or be moved offsite by currents into other areas. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway to protect it against shoreline erosion.

4.4.1.4.1.3. Potential Effects from Drilling Discharges. The primary source of the following description of discharge effects comes from Hurley and Ellis (2004). Exploration drilling occurs after seismic and other surveys have determined the location and extent of a possible hydrocarbon-bearing geological formation. Formations identified with remotely collected data may contain commercially viable hydrocarbon deposits, or they may contain only water or hydrocarbons in quantities that are uneconomical to develop.

Exploration drilling is the only way to confirm the presence of viable quantities of hydrocarbons in a prospective formation. In the event that hydrocarbons are found, further drilling of delineation wells may be required to further refine a prospect's potential for development or in order to establish the extent or commercial viability of a prospect. If development is to go ahead, several production wells may be drilled at the same site. Many aspects of drilling are common between offshore exploration and development drilling.

The potential for negative environmental effects for discharges other than drill wastes (e.g., bilge, ballast, grey water) was considered low, because volumes discharged are small and the drilling unit is typically present on the drilling location for 60-90 days.

4.4.1.4.1.3.1. Physical Effects of Drill Wastes. The particulate fraction of discharged drilling wastes tends to settle on the seafloor so that its drift, dispersion, and dilution, therefore, generally are lower than those of dissolved or buoyant discharges. Recent studies have indicated that drilling wastes can flocculate in seawater to form aggregates on the order of 0.5-1.5 mm in diameter with high settling velocities (Hurley and Ellis, 2004, citing Milligan and Hill, 1998) such that the bulk of drilling-mud discharges settle rapidly and can accumulate on the seabed (Hurley and Ellis, 2004 citing Muschenheim et al., 1995, Muschenheim and Milligan, 1996). Based on chemical indicators of drilling muds such as barium in association with total petroleum hydrocarbons, large development projects with several wells at the same location had larger zones of detection (maximum 8,000 m) than single wells (maximum 1,000 m) at similar water depths.

Resuspension or deposition processes in the benthic boundary layer tend to concentrate particulate wastes in suspension near the seabed before eventually being dispersed by currents and waves (Hurley and Ellis, 2004, citing Muschenheim and Milligan, 1996). Regional and temporal variations in physical oceanographic processes, that determine the degree of initial dilution and waste suspension, dispersion and drift in the benthic boundary layer, have a large influence on the potential zone of influence of discharged drilling wastes. The spread of contaminants originating from drilling discharges by natural activities (storm events) can be quite extensive.

4.4.1.4.1.3.2. Biological Effects of Drill Wastes. The NRC (1983) concluded that impacts from drilling operations are most severe on benthic communities. Toxicity studies both in the laboratory and the field have focused on the fate of drilling-waste discharges and their acute and chronic effects on the benthic infauna and epifauna and bottom-dwelling fish species. Most studies have focused on the physical effects of the clay fractions of the mud and/or the biological effects of the petroleum hydrocarbon contamination from the drilling fluids. Although observed impacts of drilling wastes generally been attributed to chemical toxicity or organic enrichment, there is increasing evidence to indicate that fine particles in drilling wastes contribute to the effects observed around drilling platforms. There are additional concerns about the potential for heavy metal pollution at petroleum exploration and development sites, including cadmium, lead, and mercury, which are found in drilling wastes (Hurley and Ellis, 2004, citing Cranford, 2001).

Heavy particles tend to settle near the discharge site and can form a pile on the seafloor. There is the potential that these cutting piles can smother benthic communities and result in artificial reef effects, where the piles attract marine organisms and provide substrate for epifaunal animals such as crabs to colonize. The properties of the cuttings depend on the particle size, sorption capacity of the crushed rock, and on a number of technical factors. These factors, which ultimately determine the fate and longevity of the piles, include the type and formulation of drilling fluids, physiochemical parameters in the drilling zone, conditions of the mud and cuttings contact with extracted hydrocarbons, and methods of cuttings separation and treatment.

4.4.1.4.1.3.3. Persistence of Drill Wastes. Consistent zones of detection for drilling fluids and biological impacts for water-based muds were documented. Observations of the zone of detection of water-based muds suggest that average measured background levels are reached at 1,000-3,000 m. Some single-transect values have been elevated at up to 8,000 m. Maximum sediment concentrations of synthetic-based muds were more localized than for water-based muds and were detected at distances ranging from 100-2,000 m from the discharge location. Biological impacts associated with the release of synthetic-based mud cuttings generally were detected at distances of 50-500 m from the well sites. Reductions in the abundance of a few species were detected over greater scales out to 1,000 m. While recovery of benthic communities generally was documented to occur within 1 year of completion, one case study documented that benthic species' richness and abundance were reduced at a distance of 50 m 2 years after exploratory drilling stopped (Hurley and Ellis, 2004, citing Candler et al., 1995). Overall, existing data suggest that these materials will be substantially degraded on a time scale between 1 and several years; however, the distribution and fate of these materials has not been extensively documented. The spatial area over which drilling muds are detected generally is greater than the area over which biological effects were documented.

4.4.1.4.1.4. Potential Effects from Anchor or Cable Deployment and Recovery. Dense kelp beds grow in a few areas of the Beaufort Sea (USDOI, MMS, 2003a), most notably the Boulder Patch behind the barrier islands of Stepphanson Sound (USDOI, MMS, 2002). There are few kelp beds in the Chukchi Sea, located nearshore or in coastal lagoons.

When and where a vessel anchors is at the discretion of the vessel captain. Anchoring by vessels is sometimes a necessary practice that locally may disturb the seafloor. Fish habitats may be crushed or injured during vessel anchoring practices. Anchors may not hold fast under some conditions and could drag across the seafloor, damaging sessile organisms (e.g., kelp) or their habitats (e.g., boulders). Anchoring in fragile areas (e.g., kelp beds) likely would yield more damage to fish resources and habitat than anchoring offshore in sand or mud.

On-bottom cables are sometimes used to conduct seismic surveys in shallow, nearshore waters during the open-water period. These shallow nearshore waters are some of the best areas for kelp. As the cables lay on the sea-floor, the kelp and cables can become entangled and the kelp may remain on the cable when the cable is retrieved to the surface. The more abundant the kelp is, the more entanglements can occur and more kelp can be damaged.

The magnitude of any damage to the seafloor would depend on where anchors or cables were placed. For anchors, the damage depends on whether it drags what it might drag across. For cables, some of the kelp may be returned to the seafloor if the holdfast and anchor rock are intact. This kelp would likely survive. Some kelp blades may have reproductive parts that would still function if returned to the ocean. Other pieces of kelp would decompose and contribute nutrients to the coast, much like other kelp washed up on the beaches during storms. Overall direct impacts to benthic fish habitats would be restricted to anchoring or OBC survey sites, and these limited areas would be very small compared to the total area of

benthic habitat available. Some of these effects are similar to those naturally-occurring from storms or gouging from ice keels.

4.4.1.4.1.5. Potential Effects from Petroleum Spills.

4.4.1.4.1.5.1. General Effects from Petroleum Spills to Fish Resources. Petroleum is a complex substance composed of many constituents. These constituents vary in structural complexity, volatility, and toxicity to organisms. A more detailed discussion of these differences, plus modes of release and factors affecting concentrations of oil in the water column, is found in Appendix A.

There are two general ways that oil spills adversely affect the abundance of a population: (1) through direct mortality or (2) through indirect impacts on reproduction and survival (Hilborn, 1996). In each case, the impacts might be followed by recovery to preimpact levels or by a long-term change in abundance. Additionally, long-term habitat change or a change in competitive or predation pressure could result in a long-term change in the distribution or abundance of a species.

Oil spills have been observed to have a range of effects on fish (see Rice, Korn, and Karinen, 1981; Starr, Kuwada, and Trasky, 1981; Hamilton, Starr, and Trasky, 1979; and Malins, 1977 for more detailed discussions). The specific effect depends on the concentration of petroleum present; the time of exposure; and the stage of fish development involved (eggs, larvae, and juveniles are the most sensitive). If sublethal concentrations are encountered over a sufficient duration, fish mortality is likely to occur. Sublethal effects include changes in growth, feeding, fecundity, survival, and temporary displacement.

Oil spills can more specifically affect fish resources in many ways, including the following:

- cause mortality to eggs and immature stages, abnormal development, or delayed growth due to acute or chronic exposures in spawning or nursery areas; this may occur repeatedly if generation after generation continues to spawn and/or rear offspring in contaminated areas;
- impede the access of migratory fishes to spawning habitat because of contaminated waterways;
- alter behavior;
- displace individuals from preferred habitat;
- constrain or eliminate prey populations normally available for consumption;
- impair feeding, growth, or reproduction;
- contaminate organs and tissues and cause physiological responses, including stress;
- reduce individual fitness and survival, thereby increasing susceptibility to predation, parasitism, zoonotic diseases, or other environmental perturbations;
- increase or introduce genetic abnormalities within gene pools; and
- modify community structure that benefits some fish resources and harms others.

Concentrations of petroleum hydrocarbons are acutely toxic to fishes a short distance from and a short time after a spill event (Malins, 1977; Kinney, Button, and Schell, 1969). The death of adult fish has occurred almost immediately following some oil spills (the *Florida* and *Amoco Cadiz*; Hampson and Sanders, 1969; Teal and Howarth, 1984). The majority of adult fish are able to leave or avoid areas of heavy pollution and, thus, avoid acute intoxication and toxicity. Evidence indicates that populations of free-swimming fish are not injured by oil spills in the open sea (Patin, 1999). In coastal shallow waters with slow water exchange, oil spills may kill or injure pelagic or demersal fish.

Lethal effects to adults may pose less threat to populations than damage to eggs and larvae or changes in the ecosystem supporting populations (e.g., Teal and Howarth, 1984). Floating eggs, and juvenile stages of many species can be killed when contacted by oil (Patin, 1999), regardless of the habitat.

The most serious concerns arise regarding the potential sublethal effects in fisheries resources, including commercially valued species, when exposed to chronic contamination within their habitats (Patin, 1999). The toxicity of oil pollution to aquatic populations has been seriously underestimated by standard short-term toxicity assays, and the habitat damage that results from oil contamination has been correspondingly underestimated (Ott, Peterson, and Rice, 2001). Research studies show that intertidal or shallow benthic substrates may become sources of persistent pollution by toxic polycyclic aromatic hydrocarbons (PAHs) following oil spills or from chronic discharges (Rice et al., 2000). Fish sublethal responses include a wide range of compensational changes (Patin, 1999). These start at the subcellular level and first have a biochemical and molecular nature. Recent research, mostly motivated by the *Exxon Valdez* oil spill, has found that: (1) PAHs are released from oil films and droplets at progressively slower rates with increasing molecular weight leading to greater persistence of larger PAHs; (2) eggs from demersally spawning fish species accumulate dissolved PAHs released from oiled substrates, even when the oil is heavily weathered; and (3) PAHs accumulated from aqueous concentrations of <1 part per billion (ppb) can lead to adverse sequelae (i.e., a secondary result of disease or injury) appearing at random over an exposed individual's lifespan (Rice et al., 2000). These adverse effects likely result from genetic damage acquired during early embryogenesis caused by superoxide production in response to PAHs. Therefore, oil poisoning is slow acting following embryonic exposure, and adverse consequences (e.g., prematurely truncated lifespan, impaired reproductive potential, unnatural physical or behavioral limitations) may not manifest until much later in life. The frequency of any one symptom usually is low, but cumulative effects of all symptoms may be considerably higher (Rice et al., 2000). For example, if chronic exposures persist, stress may manifest sublethal effects later in a form of histological, physiological, behavioral, and even population-level responses, including impairment of feeding, growth, and reproduction (Patin, 1999). Chronic stress and poisoning also may reduce fecundity and survival through increased susceptibility to predation, parasite infestation, and zoonotic diseases. These can affect the population abundance and, subsequently, community structure. For more information summarizing the various adverse effects (both individual and population level) to fish fauna or their habitats see Patin (1999:Tables 29 and 30).

4.4.1.4.1.5.2. Aspects of Fish Life Histories that Make them Vulnerable to Effects of Oil.

Several aspects of fish life histories may make arctic fish populations vulnerable to effects from spilled oil. In particular, adult fish generally are unlikely to suffer great mortality as a result of an oil spill; however, diadromous fishes in the estuarine/nearshore, brackish water ecotone might be adversely affected by having their access to feeding, overwintering, or spawning grounds impeded. Effects of an oil spill could include increased swimming activity; decreased feeding; interference with movements to feeding, overwintering, or spawning areas; impaired homing abilities; and death of some adult or juvenile fishes. Fish also may suffer increased physiological stress when making the adjustment from fresh to brackish or marine water and vice versa that later result in mortality. Adverse effects are more likely for fishes that make extensive migrations from natal streams; for fishes with high fidelity to natal streams; and for fishes that overwinter in nearshore environments (such as the major river deltas). Recruitment or survival of fishes could be reduced by oil adversely affecting the spawning of adults, the development of early life-history stages repeated across generations, movement and feeding patterns of adults or juveniles, or overwintering juveniles or adults.

Larvae, eggs, and juvenile fishes generally are more sensitive to oil spills than are adult fishes. In particular, species with floating eggs (e.g., arctic cod) or eggs and larvae in more vulnerable positions (e.g., eggs and developing larvae of pink salmon or capelin on or proximate to contaminated substrates in the intertidal and/or shallow subtidal) could suffer extensive mortality (depending on the amount and type of oil spilled, the areal extent of the spill, etc.). Nearshore demersal eggs or larval fishes spending time in coastal areas are the fish most vulnerable to adverse effects of spilled oil. These vulnerable categories include pink salmon, capelin, fourhorn sculpin, and snailfish, which can have great bursts of abundance in nearshore areas (e.g., Morrow, 1980, citing Andriyashev, 1954; Westin, 1970).

Growth, recruitment, and/or reproduction could be adversely affected, because oil may increase the already high mortality of larvae in the plankton by increasing the length of time in the plankton or by decreasing planktonic food.

There are several potential pathways that an oil spill could impact spawning substrates and fish such as capelin and pink salmon. Fishes unable to detect a spill could experience direct mortality. Eggs laid in contaminated spawning habitats could experience direct mortality or sublethal effects. Sublethal effects could be manifested at subsequent life stages. For example, young fish that survive to smolt could be undersized when entering the ocean and either become prey for larger fish that normally could not hunt them or, similarly, be unable to capture appropriately sized prey. If an oil spill occurred and decimated a year-class of young from one area, the effects likely would adversely influence successive generations' ability for recovery.

Eggs deposited in the proximity of the contaminated substrate over a series of years likely would be exposed to oil (PAHs) retained in the substrate, as PAHs in weathered oil can be biologically available for long periods and very toxic to sensitive life stages, subsequently leading to lethal and sublethal effects to those offspring of successive generations. It is not clear what effects PAH exposure may have on the dynamics of the region's meta-population; however, the repeated use of a contaminated spawning site could result in consistently lower return-per-spawner ratios or the site could be unavailable for use for multiple generations. Recovery would depend on how long oil persists in the localized habitat, the sensitivity of capelin to exposure and their ability to detect and avoid contaminated substrates. Fishes able to detect and avoid a contaminated spawning area could use unsuitable or more distant alternative spawning sites resulting in high egg/larvae loss or other potential energetic costs that affect fecundity.

4.4.1.4.1.5.3. Oil-Spill Effects to Fish Populations: Lessons from the *Exxon Valdez* Oil Spill. In this section we describe what was learned about long-term ecosystem responses resulting from the Exxon Valdez Oil Spill and then outline generalized common effects to multiple fish species, and conclude with potential species-specific effects to Pacific salmon and herring.

Long-Term Ecosystem Responses. Peterson et al. (2003) described the long-term ecosystem response to the *Exxon Valdez* oil spill (EVOS). Peterson et al. (2003) stated:

The ecosystem response to the 1989 spill of oil from the Exxon Valdez into Prince William Sound [PWS], Alaska, shows that current practices for assessing ecological risks of oil in the oceans and, by extension, other toxic sources should be changed. Previously, it was assumed that impacts to populations derive almost exclusively from acute mortality. Unexpected persistence of toxic sub-surface oil and chronic exposures in the Alaskan coastal ecosystem, even at sublethal levels, has continued to affect the environment. Delayed population reductions and cascades of indirect effects postponed recovery. Development of ecosystem-based toxicology is required to understand and ultimately predict chronic, delayed, and indirect long-term risks and impacts.

...uncertainties do little to diminish the general conclusions: oil persisted beyond a decade in surprising amounts and in toxic forms, was sufficiently bioavailable to induce chronic biological exposures, and had long-term impacts at the population level. Three major pathways of induction of long-term impacts emerge: (i) chronic persistence of oil, biological exposures, and population impacts to species closely associated with shallow sediments; (ii) delayed population impacts of sublethal doses compromising health, growth, and reproduction; and (iii) indirect effects of trophic and interaction cascades, all of which transmit impacts well beyond the acute-phase mortality.

Conclusions by Peterson et al. (2003) specifically pertinent to fish resources include:

- Chronic exposures of sediment-affiliated species.
- Chronic exposures enhanced mortality for years.
- After the spill, fish embryos and larvae were chronically exposed to partially weathered oil in dispersed forms (citing Murphy et al., 1999).
- Laboratory experiments showed that these multi-ringed polycyclic aromatic hydrocarbons (PAHs) from partially weathered oil at concentrations as low as 1 ppb are toxic to pink salmon eggs exposed for the months of development and to herring eggs exposed for 16 days (citing Marty, Heintz, and Hinton, 1997, Heintz et al., 2001).
- This process explains the elevated mortality of incubating pink salmon eggs in oiled rearing streams for at least 4 years after the oil spill. (citing Bue, Sharr, and Seeb, 1998).

Sublethal exposures leading to death from compromised health, growth, or reproduction:

- Oil exposure resulted in lower growth rates of salmon fry in 1989 (citing Rice et al., 2001), which in pink salmon reduce survivorship indirectly through size-dependent predation during the marine phase of their life history (citing Willette et al., 2000).
- After chronic exposure as embryos in the laboratory to < 20 ppb total PAHs, which stunted their growth, the subsequently marked and released pink salmon fry survived the next 1.5 years at sea at only half the rate of control fish (citing Heintz et al., 2001).
- In addition, controlled laboratory studies showed reproductive impairment from sublethal exposure through reducing embryo survivorship in eggs of returning adult pink salmon that had previously been exposed in 1993 to weathered oil as embryos and fry (citing Heintz et al., 1999).
- Abnormal development occurred in herring and salmon after exposure to the Exxon Valdez oil (citing Carls et al., 2001; Marty, Heintz, and Hinton, 1997).

Cascades of indirect effects:

- Indirect effects can be as important as direct trophic interactions in structuring communities (citing Schoener, 1993).
- Cascading indirect effects are delayed in operation because they are mediated through changes in an intermediary.
- Perhaps the two generally most influential types of indirect interactions are (i) trophic cascades in which predators reduce abundance of their prey, which in turn releases the prey's food species from control (citing Estes et al., 1995) and (ii) provision of biogenic habitat by organisms that serve as or create important physical structure in the environment (citing Jones et al., 1994).
- Current risk assessment models used for projecting biological injury to marine communities ignore indirect effects, treating species populations as independent of one another (citing Peterson, 2001; Rice et al., 2001).
- Indirect interactions lengthened the recovery process on rocky shorelines for a decade or more (citing Peterson, 2001).
- Expectations of rapid recovery based on short generation times of most intertidal plants and animals are naive and must be replaced by a generalized concept of how interspecific interactions will lead to a sequence of delayed indirect effects over a decade or longer (citing Peterson, 2001).
- Indirect interactions are not restricted to trophic cascades or to intertidal benthos. Interaction cascades defined broadly include loss of key individuals in socially organized populations, which then suffer subsequently enhanced mortality or depressed reproduction.
- Ecologists have long acknowledged the potential importance of interaction cascades of indirect effects. New synthesis of 14 years of EVOS studies documents the contributions of delayed, chronic, and indirect effects of petroleum contamination in the marine environment.

- Old paradigm in oil ecotoxicology – oil toxicity to fish: oil effects solely through short-term (~4 day) exposure to water-soluble fraction (1- to 2-ringed aromatics dominate) through acute narcosis mortality at parts per million concentrations.
- New paradigm in oil ecotoxicology – oil toxicity to fish. Long-term exposure of fish embryos to weathered oil (3- to 5-ringed PAHs) at ppb concentrations has population consequences through indirect effects on growth, deformities, and behavior with long-term consequences on mortality and reproduction.

General Effects Applicable all Fish Species. Carls et al. (2005) concluded that: (1) induction of cytochrome P4501A (CYP1A) is statistically correlated with adverse effects at cellular, organism, and population levels in pink salmon and can be used to predict these responses; (2) exposure of pink salmon embryos and larvae to oil caused a variety of lethal and sublethal effects; and (3) the combined results from a series of embryo-larval exposure experiments spanning 5 brood years are consistent and demonstrate that CYP1A induction is related to a variety of lethal and sublethal effects, including abnormalities, reduced growth and diminished marine survival. CYP1A induction has been observed in many species and in many of the same tissues (Carls et al., 2005, citing, e.g., Sarasquete and Segner, 2000, Stememan et al., 2001).

Short et al. (2003) concluded that habitat damage resulting from oil contamination is underestimated by acute toxicity assays. They describe that nearshore substrates oiled by spills may become persistent pollution sources of toxic PAHs. Their findings from EVOS research include: (1) PAHs are released from oil films and droplets at progressively slower rates with an increasing molecular weight leading to greater persistence of larger PAHs; (2) eggs from demersally spawned fish species accumulate dissolved PAHs released from oiled substrates, even when the oil is heavily weathered; and (3) PAHs accumulated by embryos from aqueous concentrations of <1 ng/L can lead to adverse sequelae appearing at random over the lifespan of an exposed cohort, probably as a result of damage during early embryogenesis. They conclude that oil is a slow-acting poison, and that toxic effects may not manifest until long after exposure (see Fig. 4.4.1.4-1). Several highly pertinent points taken from Short et al. (2003) include:

- Fish and oil do not mix...the threat is not from acutely toxic concentrations that result in immediate fish kills, but in the more subtle effects of low-level oil pollution to sensitive life stages. Incubating eggs are very sensitive to long-term exposure to PAH concentrations because they may sequester toxic hydrocarbons from low or intermittent exposures into lipid stores for long periods and because developing embryos are highly susceptible to the toxic effects of pollutants (citing Mary et al., 1997, Carls et al., 1999, Heintz et al., 1999, 2000). PAHs in weathered oil can be biologically available for long periods and very toxic to sensitive life stages. The result is that fewer juvenile fish survive, so that recruitment from the early life stages is reduced and adult populations may not be replaced at sustainable levels. Eventually, adult populations may gradually decline to unsustainable numbers.
- Streams and estuaries sustain the vulnerable early developmental life stages of many fish species. Herring spawn their eggs in areas of reduced salinities, salmon early life stages use both stream and estuary for much of the first year of life, and the juveniles of many marine species use the estuaries for nursery grounds. The very qualities of these natal and rearing habitats that provide protection from predators also make both the habitat and, by extension, the species vulnerable to pollution. The sediments of salmon streams and many nearshore estuaries are capable of harboring oil for extended periods with slow release.
- Habitats used by demersally spawning fish such as salmon, herring, and capelin are particularly vulnerable to the effects of oil coming ashore on beaches and the spawning gravels of streams.
- Fish natal and rearing habitats are clearly vulnerable to oil poisoning from chronic discharges under the current regulatory framework. Oil discharges into these habitats are covered by water quality standards based on acute LC₅₀ results for more tolerant life stages, which may seriously

underestimate cumulative adverse effects, even when presumably conservative safety factors of 0.01 are applied. These water quality standards need to be revised if we are to protect these habitats.

- Chronic pollution seldom results in floating fish carcasses. Instead, there is continued habitat contamination, erosion of populations, and when coupled over time with other events such as hard winters, other habitat loss, increase in predators or fishing, decreases in food availability at a critical life stage, etc. may eventually result in unsustainable populations in high impact environments. Species with life history strategies that rely on streams or estuaries for reproduction are most vulnerable.

In the absence of further laboratory study with other fish species, Short et al. (2003) suggested a toxicity threshold of approximately 1 ng/L of aqueous PAHs for habitats where fish eggs and larvae rear, derived from studies on sensitive early life stages of pink salmon and Pacific herring. They also recommended that government standards for dissolved aromatic hydrocarbons should be revised to reflect this threshold for protection of critical life stages and habitats of fish.

Demersal marine fishes, particularly those associated with nearshore waters, are known to be impacted by oil spills. Demersal fishes may at times inhabit the benthos or pelagic waters. Vertical changes in depth may be responses to factors such as light conditions and foraging opportunities. For example, Pacific sandlance inhabit the water column nearshore during the day but at night, they bury themselves in soft bottom sediments. They also are known to overwinter by burying in sediments, with a preference for fine or coarse sand substrate. This makes them particularly vulnerable to oil spills impacting nearshore areas.

Demersal fishes inhabiting oil-polluted areas may suffer similar lethal and sublethal effects (e.g., egg mortality, developmental aberrations, reduced survival, etc.) as reported for pelagic finfishes, although not necessarily of the same magnitude. For example, Moles and Norcross (1998) found that juvenile yellowfin sole, rock sole, and Pacific halibut experienced reduced growth following 30-90 days of exposure to sediments laden with Alaska North Slope crude oil. Changes in fish health bioindicators after 90 days—i.e., increases in fin erosion, liver lipidosis, gill hyperplasia, and gill parasites—coupled with decreases in macrophage aggregates, occurred at hydrocarbon concentrations (1,600 µg/g) that reduced growth 34-56% among the demersal fishes. Moles and Norcross (1998) concluded that: (1) chronic hydrocarbon pollution of nearshore nursery sediments could alter growth and health of juvenile flatfishes; and (2) recruitment of juveniles to the fishery may decline because of increased susceptibility to predation and slower growth.

Yelloweye, quillback, and copper rockfish examined for histopathological lesions and elevated levels of hydrocarbons in their bile after the EVOS indicated significant differences between oiled and control locations (Hoffman, Heppler, and Hansen, 1993). Additionally, at least five rockfish examined were killed by exposure to oil. While the authors noted no population-level effect in these species, these data indicate spilled oil reached and exposed demersal fishes to both sublethal and lethal toxic effects.

Some demersal or pelagic species are sensitive to oiled substrates, and may be displaced from preferred habitat that is oiled. Other species may not be sensitive to contaminants and use contaminated sites, thereby prolonging their exposure to contaminants. Pinto, Pearson, and Anderson (1984) found that sand lance avoided sand contaminated with Prudhoe Bay crude oil in an experimental setting. Moles, Rice, and Norcross (1994) exposed juvenile rock sole, yellowfin sole, and Pacific halibut to laboratory chambers containing contaminated mud or sand offered in combination with clean mud, sand, or granule. The fishes were able to detect and avoid heavily oiled (2%) sediment but did not avoid lower concentrations of oiled sediment (0.05%). Oiled sediment was favored over nonoiled sediment, if the nonoiled sediment was of the grain size not preferred by that species. Oiled sand or mud was always preferred over nonoiled granule. The authors concluded that the observed lack of avoidance at

concentrations likely to occur in the environment may lead to long-term exposure to contaminated sediment following a spill.

Hydrocarbon exposure in demersal fishes often results in an increase in gill parasites (Khan and Thulin, 1991; MacKenzie et al., 1995). Moles and Wade (2001) experimentally tested adult Pacific sand lance's susceptibility to parasites when exposed to oil-contaminated sediments for 3 months. They found that sand lance exposed to highly oiled substrates had the greatest mean abundance of parasites per fish. Chronic exposure to harmful pollutants such as hydrocarbons coupled with increased parasitism degrades individual fitness and survival.

Species-Specific Effects from Oil Spills. Oil-spill impacts to Alaskan fishes are best known for populations of Pacific salmon and Pacific herring that were impacted by the EVOS. Because Pacific salmon and Pacific herring occur in the Alaskan Chukchi Sea, studies of the impacted populations are useful to elucidate potential impacts that an oil spill may have on arctic populations.

Pacific Salmon. Salmon are able to detect and avoid hydrocarbons in the water (Weber et al., 1981), although some salmon may not avoid oiled areas and become temporarily disoriented but eventually return to their home stream (Martin, 1992). Adult salmon remain relatively unaffected by oil spills and are able to return to natal streams and hatcheries, even under very large oil-spill conditions, as evidenced by pink and red salmon returning to PWS and red salmon returning to Cook Inlet after the EVOS. When oil from the EVOS entered Cook Inlet, the Alaska Department of Fish and Game (ADF&G) closed the sockeye salmon commercial fishery in Cook Inlet. This evidently resulted in overescapement of spawning fish in the Kenai River system for the third consecutive year. Overescapement in 1987 was due to a previous spill and, in 1988 there was a naturally high escapement. Salmon smolts appeared to decline. Although the mechanism for the apparent decline in smolt abundance is uncertain, the result of overescapement and too many salmon fry to be supported by the available prey may be the cause. The extent of the decline was speculative. Managers originally predicted that adult salmon returns in 1994 and 1995 would be below escapement goals, but the 1994 returns were three times that forecasted. Escapement goals were met for 1995, and commercial fisheries were operating. The EVOS Trustee Council listed pink and red salmon as “recovered” in 2002, 13 years after the spill.

Many fish species are most susceptible to stress and toxic substances during the egg and larval stages than at the adult stage. Intertidal areas contaminated by spilled oil may persist for years and represent a persistent source of harmful contaminants to aquatic organisms. Contamination of intertidal spawning-stream areas for pink salmon caused increased embryo mortality and possible long-term developmental and genetic damage (Bue, Sharr, and Seeb, 1998). The embryo, a critical stage of salmon development, is vulnerable because of its long incubation in intertidal gravel and its large lipid-rich yolk, which will accumulate hydrocarbons from chronic, low-level exposures (Marty, Heintz, and Hinton, 1997; Heintz, Short, and Rice, 1999). Pink salmon (often intertidal spawners) embryos in oiled intertidal stream areas of PWS continued to show higher mortality than those in nonoiled stream areas through 1993, more than 4 years after the oil spill, but appeared to recover in 1994 (Bue, Sharr, and Seeb, 1998).

Experiments conducted by Heintz, Short, and Rice (1999) demonstrate that aqueous-total PAH concentrations as low as 1 ppb derived from weathered EVOS oil can kill pink salmon embryos localized downstream from oil sources. Their study also found a 25% reduction in survival during incubation of brood fish exposed to 18 ppb. Other studies examining egg and fry survival showed no difference between oiled and nonoiled locations (Brannon et al., 1993) except in two cases—one that showed higher mortality at a nonoiled stream, and another that showed higher mortality at the high-tide station of an oiled stream. These studies did not measure PAHs in stream water or in salmon embryos, were statistically underpowered, and were insufficient in duration to test for the manifestation of adverse

effects from low-level PAH exposures (Murphy et al., 1999). Results published by Murphy et al. (1999) and Heintz, Short, and Rice (1999) contradict other scientists' conclusions that PAH concentration in spawning substrate after the spill was too low to adversely affect developing salmon (i.e., Brannon et al., 1995; Maki et al., 1995; Brannon and Maki, 1996).

Several studies demonstrated indirect and chronically adverse effects of oil to intertidal fish at levels below the water quality guidelines of 15 ppb. Experiments conducted by Heintz, Short, and Rice, (1999) demonstrate that between the end of chronic exposure to embryonic salmon and their maturity, survival was reduced by another 15%, resulting in the production of 40% fewer mature adults than the unexposed population. They concluded the true effect of the exposure on the population was 50% greater than was concluded after evaluating the direct effects. Additional research found that fewer exposed fish from one experimentally exposed egg brood survived life at sea and returned as mature adults compared to unexposed fish (Heintz et al., 2000). Moreover, Heintz et al. (2000) experimental data show a dependence of early marine growth on exposure level; unexposed salmon increased their mass significantly more than salmon exposed to crude oil as embryos in eggs. Heintz et al. (2000) concluded that exposure of embryonic pink salmon to PAH concentrations in the low parts per billion produced sublethal effects that led to reduced growth and survival at sea. Studies, therefore, indicate that examination of short-term consequences underestimate the impacts of oil pollution (Heintz et al., 2000; Rice et al., 2000; Ott, Peterson, and Rice, 2001).

Carls et al. (2005) studied CYP1A-induction pink salmon embryos exposed to crude oil and linked adverse effects at the cellular, organism, and population levels. The CYP1A is a particular group of mono-oxygenase enzymes that mediates oxidation of petroleum hydrocarbons and other xenobiotics, thereby facilitating their excretion (Wiedmer et al., 1996, citing Jimenez and Stegeman 1990). Carls et al. (2005) found that CYP1A induction (i.e., an exposure that introduces one to something previously unknown) indicates that long-term damage is probable, leading to reduced survival. In similar exposures to PAH with pink salmon embryos, earlier studies found both short- and long-term effects, including poor adult returns when embryos were exposed to similar dose levels (Carls et al., 2005, citing Marty et al. 1997; Heintz, Short, and Rice, 1999; Heintz et al., 2000). Specifically, depressed fry growth and significantly reduced marine survival were observed after exposure of pink salmon embryos to <5.2 µg/L aqueous-total PAH concentrations (Carls et al., 2005, citing Heintz et al. 2000). Tests confirm that long-term consequences can be expected from low exposure doses to embryos. Theirs and other studies demonstrate that CYP1A induction in embryos is linked to reduced marine survival and, therefore, population-level effects.

Reduced growth potential in the marine environment, caused by toxic action in oil-exposed embryos, probably is the key functional change that leads to the distinct survival disadvantage and fewer returning adult spawners (Carls et al., 2005). Rapid fry growth after emigration to the marine environment is important to escape mortality from size-selective predation (Carls et al., 2005, citing Parker, 1971, Healey 1982, Hargreaves and LeBrasseur, 1985), thus, placing oil-exposed fish at a disadvantage. In oil-exposure tests with pink salmon embryos followed by released fry, reduced marine survival of pink salmon adults has been directly observed in 3 different brood years (1993, 1995, and 1998; Carls et al., 2005, citing Heintz et al., 2000). Depressed marine survival was consistently correlated with depressed growth rate 4-10 months after emergence and was a more sensitive measure of significant response in 1995 fish than growth rate.

Carls et al. (2005) determined that the model of activity demonstrated by their study is consistent with a similar cascade of effects described in PWS after the EVOS. In juvenile pink salmon in marine water, CYP1A was induced by oil, and growth slowed (Carls et al., 2005, citing Carls et al., 1996, Wertheimer and Celewycz, 1996, Willette, 1996). Geiger et al. (1996, as cited by Carls et al., 2005) estimated that approximately 1.9 million wild pink salmon failed to return as adults in 1990 because of poor growth and

reduced survival (about 28% of the potential wild-stock production in southwestern PWS). Pink salmon embryos incubating in the intertidal reaches of streams were exposed to PAH from oil-coated intertidal sediment; CYP1A was induced and survival was significantly reduced through 1993 (Carls et al., 2005, citing Bue et al., 1996, 1998, Wiedmer et al., 1996, Craig et al., 2002, Carls et al., 2003). Gieger et al. (1996, as cited by Carls et al., 2005) estimated that 60,000-70,000 pink salmon failed to return as adults in 1991 and 1992, respectively, as a result of toxic exposure. Hence, the laboratory study is consistent with these field data.

Exposure to PAH during the earliest stages of development may increase significantly the risk of damage to developing embryos, consistent with the general observation that early life stages are highly vulnerable to pollutants (Carls et al., 2005, citing, e.g., Moore and Dwyer, 1974) which can have immediate, secondary, and delayed effects. Carls et al. (2005) reported some macroscopic abnormalities that were positively correlated with total PAH exposure. Abnormalities that were positively correlated with exposure were ascites, bulging eyes, malformed head, short opercular plates, external hemorrhaging, mouth or jaw malformation, and deformed caudal fin. Unusual pigmentation and tumors were negatively correlated with exposure, probably because embryos with these developmental problems were less likely to survive oil exposure (Carls et al., 2005). Permanent multiple defects are likely to have lasting consequences, such as poorer growth and marine survival (Carls et al., 2005, citing, e.g., Heintz et al., 2000).

Information regarding impacts from the EVOS on pink salmon are relevant to this assessment, because other salmon species (e.g., chum and coho) inhabit the coastal habitats of the Chukchi Sea and the biological responses of salmon species to PAH's and oil likely are similar.

Pacific Herring. Some Pacific herring stocks of the Gulf of Alaska were impacted appreciably by past oil spills. The EVOS occurred a few weeks before Pacific herring spawned in PWS. A considerable portion of spawning habitat and staging areas in PWS were contaminated by oil. Adult herring returning to spawn in PWS in 1989 were relatively unaffected by the spill and successfully left one of the largest egg depositions since the early 1970s. Total herring-spawn length for 1989 was 158 km, with 96% in nonoiled areas, 3% in areas of light to very light oiling, and only 1% in areas characterized as moderate to heavy oiling (Pearson, Mokness, and Skalski, 1993). About half of the egg biomass was deposited within the oil trajectory, and an estimated 40-50% sustained oil exposure during early development (Brown et al., 1996). Other researchers estimated that more than 40% of the areas used by the PWS stocks for spawning and more than 90% of the nearshore nursery areas were exposed to spilled crude oil (Biggs and Baker, 1993).

McGurk and Brown (1996) tested the instantaneous daily rates of egg-larval mortality of Pacific herring at oiled and nonoiled sites; they found that the mean egg-larval mortality in the oiled areas was twice as great as in the nonoiled areas, and larval growth rates were about half those measure in populations from other areas of the North Pacific Ocean. Norcross et al. (1996) collected Pacific herring larvae throughout PWS in 1989 following the EVOS. They found deformed larvae both inside and outside of areas considered as oiled. Many larvae exhibited symptoms associated with oil exposure in laboratory experiments and other oil spills. These included morphological malformations, genetic damage, and small size. Growth was stunted during developmental periods. Brown et al. (1996) noted the resulting 1989 year-class displayed sublethal effects in newly hatched larvae, primarily premature hatch, low weights, reduced growth, and increased morphologic and genetic abnormalities. In newly hatched larvae, developmental aberration rates were elevated at oiled sites, and in pelagic larvae genetic damage was greatest near oiled areas of southwestern PWS. Brown et al. (1996) estimated that oiled areas produced only 0.016×10^9 pelagic larvae compared with 11.82×10^9 nonoiled areas. Kocan et al. (1996) exposed Pacific herring embryos to oil-water dispersions of Prudhoe Bay crude oil in artificial seawater and found

that genetic damage was the most sensitive biomarker for oil exposure, followed by physical deformities, reduced mitotic activity, lower hatch weight, and premature hatching.

Herring populations are dominated by occasional, very strong year classes that are recruited into the overall population. The 1988 prespill year-class of Pacific herring was very strong in PWS and, as a result, the estimated peak biomass of spawning adults in 1992 was very high. Despite the large spawning biomass in 1992, the population exhibited a density-dependent reduction in size of individuals, and in 1993 there was an unprecedented crash of the adult herring population. The 1989-year class was a minority of the 1993 spawning assemblage, one of the smallest cohorts observed in PWS, and it returned to spawn with an adult herring population reduced by approximately 75%, apparently because of a widespread epizootic. A viral disease and fungus may have been the immediate agents of mortality or a consequence of other stresses, such as a reduced food supply and increased competition for food.

Carls, Marty, and Hose (2002) published a synthesis of the toxicological impacts of the EVOS on Pacific herring. They compared and reinterpreted published data from industry and government sources as relating to Pacific herring in PWS that were affected by the EVOS and a 75% collapse in the adult population in 1993. They concluded that significant effects extended beyond those predicted by visual observation of oiling and by toxicity information available in 1989. Oil-induced mortality probably reduced recruitment of the 1989 year-class into the fishery but was impossible to quantify, because recruitment generally was low in other Alaskan herring stocks. Significant adult mortality was not observed in 1989; biomass remained high through 1992 but declined precipitously in winter 1992-1993. The collapse was likely caused by high population size, disease, and suboptimal nutrition, but indirect links to the spill cannot be ruled out.

Information regarding impacts from the EVOS on populations of Pacific herring is relevant to this assessment, because the biological responses of herring to PAHs and oil likely are representative for other fish species (e.g., capelin and Pacific sand lance) that also inhabit the Chukchi and Beaufort seas and may spawn on intertidal or nearshore substrates along the coast.

General Effects Summary. The controlled EVOS studies referenced above were necessary to demonstrate that when oil contaminates natal habitats, there can be both immediate and delayed effects, especially if oil persists in the natal habitat. Evaluating oil toxicity in a controlled environment allowed researchers to demonstrate the potential mechanism for immediate and long-term effects to pink salmon and herring from exposure to both new and weathered oil in the environment. However, measuring in situ impacts and recovery of pink salmon from oil exposure in PWS was demonstrated to be exceptionally complicated because of the significant amount of straying by both wild and hatchery-produced pink salmon. In some areas of southwestern PWS, straying of intertidal stocks has been shown to be as high as 54% (more than half of a stream's adult pink salmon escapement were comprised of fish that originated from a different natal stream) (Wertheimer et al., 2000). In addition, once researchers were able to distinguish hatchery-produced pink salmon via thermally marked otoliths, hatchery-produced fish, in some cases, were shown to exceed the number of wild fish in a given stream. While the high straying rates documented in PWS made assessment of population-level effects considerably more problematic; this same phenomena likely hastened the recovery of pink salmon throughout the oil-impacted areas.

The MMS reviewed the recovery status of injured fish resources tracked by the EVOS Trustee Council (Trustee Council). The Trustee Council considered recovery essentially to be “a return to conditions that would have existed had the spill not occurred” and is considered herein to equate to a return of the affected population(s) to their former status. Pacific herring, as of 2008, are not recovering. This equates to six generations since the EVOS (i.e., spring 1989). Pink salmon were listed as “not recovering” until 1997, at which time they were regarded as “recovering.”

Pink salmon were listed as “recovered” as of 2002, as were sockeye salmon. Therefore, 6.5 generations passed since the spill before pink salmon were considered by the Trustee Council to be recovered. This information supports the long-term effects of crude oil on herring and salmon described by Carls et al. (2005), Short et al. (2003), Peterson et al. (2003), and others noted above, as well as capturing the lingering and indirect effects of the EVOS.

4.4.1.4.1.5.4. Species-Specific Effects. This section considers effects on diadromous species; marine pelagic species; demersal species; capelin (a marine species that spawns along the Arctic coast); and Pacific salmon.

Diadromous Fishes. Diadromous fishes of importance because of abundance, life history, or use in domestic fisheries are least cisco, Dolly Varden char, and broad whitefish. A number of diadromous species in the region have complicated life-history patterns that are not fully understood. For the most part, diadromous fishes in the Chukchi and Beaufort seas, unlike Pacific salmon, spend the major part of their lives in freshwater rivers and lakes but undertake seasonal migrations to coastal regions in the ice-free season to feed or overwinter. The details of foraging migrations of the more abundant diadromous fishes appear to vary not only among species but among life-history stages of the same species.

These differences in migratory habits lead to spatial and temporal differences in the relative abundance of different species and life stages in the nearshore zone (Bond, 1987; Cannon and Hachmeister, 1987). Thus, an oil spill contacting the nearshore environment might affect various species and age classes of anadromous fishes as they move to feeding, overwintering, or spawning grounds.

Marine Pelagic Species. Fish populations having basically pelagic distributions are expected to be little affected by spills (with the exceptions of pink salmon, capelin, and the cryopelagic species); most of them are thought to have broad distributions in the proposed sale areas. Even if larvae, which generally are more sensitive, are affected, only a portion of those in the ichthyoplankton would be harmed; and the effects would be difficult to determine, given the high natural mortality of fish larvae and the natural variability of recruitment from year to year. If some adults were killed, recruitment into the population might not be affected, because for marine fish species having planktonic larvae, there is little correlation between the size of the adult population and recruitment. Effects on recruitment would be particularly difficult to assess, because very few studies of offshore fishes have been made. Effects might be most noticeable if predators of these pelagic fishes decline in abundance or fail to reproduce, but the cause of such an effect might not be apparent.

Marine Demersal Species. Demersal fishes in oceanic waters are not expected to be affected by oil spills, because the likelihood of oil reaching the sea bottom in the ocean in any appreciable amounts or over an extensive area is very small. However, demersal coastal fishes inhabiting shallow, soft-bottomed areas could be affected by a spill, if the water column is mixed and oil comes to contaminate sediments and/or in the shallows (Moulton, Fawcett, and Carpenter, 1985; Craig and Halderson, 1981).

Arctic Cod. For arctic cod, a species that is patchy in distribution, has floating eggs, and associates with ice cover during early life-history stages, it may be extremely difficult to determine the effect of an oil spill. Adult arctic cod have been reported to suffer 50% mortality (LC_{50}) at concentrations of 1,569 ppm \pm 0.004 oil over an 8-day period (USDOC, NOAA, NMFS, NWAFC, 1979, as cited by Starr, Kawada, and Trasky, 1981).

The abundance of arctic cod sometimes is very high in coastal surface waters. Jarvela and Thorsteinson (1999) found annual mean densities of arctic cod in the 0- to 2-m-depth interval of their study area as 50.6 per 1,000 m³ in 1990, and 1.8 per 1,000 m³ in 1991. Their mean densities of age-0 arctic cod in the

surface waters during 1990 and 1991 were within the range of previously reported late summer-fall values, both within the study area and elsewhere in the North American Arctic. In the Prudhoe Bay area, estimated densities were 14.2/1,000 m³ in 1979 (Jarvela and Thorsteinson, 1999, citing Tarbox and Moulton, 1980) and 15.5/1,000 m³ in 1988 (Jarvela and Thorsteinson, 1999, citing Houghton and Whitmus, 1988). In Simpson Lagoon, monthly mean surface densities ranged between 0 and 82/1,000 m³ in 1977 and 1978 (Jarvela and Thorsteinson, 1999, citing Craig and Griffiths, 1978, Craig et al., 1982).

Jarvela and Thorsteinson (1999) also noted: (1) the size composition of individual catches indicates that arctic cod generally were segregated into discrete size or age groups; (2) a few large catches of arctic cod and capelin during the later period constituted most of the annual catch in each year; and (3) the densities of all species except capelin declined from 1990-1991.

Although arctic cod can be extremely abundant in nearshore lagoon areas, the importance of nearshore versus offshore environments to the lifecycle is not known (Craig et al., 1982). Although it is known that juvenile arctic cod associated with floating ice, it is unknown to what degree this association contributes to the development and survival of young fishes later recruiting to the breeding population. If early life-history stages of arctic cod were concentrated in nearshore environments, in patches in the open ocean, or under floating ice, they certainly would be more vulnerable to effects from an oil spill impacting such habitats.

Capelin. Capelin spawn in coastal sandy areas in the Beaufort and Chukchi seas in June, July, and August. They are highly specific with regard to spawning conditions, making them highly vulnerable to an oil spill affecting their spawning habitat. At spawning grounds, capelin segregate into schools of different sexes. The general pattern seems to be that ripe males await opportunities to spawn near the beaches, while large schools, mainly composed of relatively inactive females, remain for several weeks off the beaches in slightly deeper water (i.e., staging area). As these females ripen, individuals proceed to the beaches to spawn. Thus, most males remain in attendance near the beaches and join successive small groups of females that spawn and depart from the area. Capelin spawn at about 2 years of age, and many individuals die after spawning (Jangaard, 1974).

Capelin eggs are demersal and attach to gravel on the beach or on the sea bottom. The incubation period varies with temperature, and hatching has been demonstrated to occur in about 55 days at 0°C, 30 days at 5°C, and 15 days at 10°C. Johannessen (1976) showed hatching of capelin eggs to be negatively affected by concentrations of 10-25mg/L (100-250 ppb) of crude oil. Capelin spawning on substrates contaminated by spilled oil expose their eggs and larvae to PAHs that likely would result in acute and chronic lethal and sublethal effects that decrease capelin abundance and delay recovery of the affected population(s) for three or more generations. Direct and indirect adverse effects affecting capelin are likely to change vital rates; changed vital rates within populations are modeled to significantly affect population dynamics (Koons, Rockwell, and Grand, 2006).

Newly hatched capelin larvae soon assume a pelagic existence near the surface, where they remain until winter cooling sets in, when they move closer to the sea bottom until waters warm again in spring. Jarvela and Thorsteinson (1999) noted that coastal waters appear to be an important habitat for age-0 capelin throughout the summer, whereas older fish seem to be present for comparatively brief periods during spawning runs. However, their study was not designed to investigate actual spawning sites. An oil spill occurring in coastal waters after a spawning event likely would adversely impact newly hatched capelin, resulting in acute mortality of much or most of the affected population's cohort.

An oil spill occurring in coastal waters during summer likely would adversely impact feeding activity of capelin. Some larval and juvenile capelin not experiencing acute mortality as a result of exposure to oil may directly or indirectly have their feeding inhibited and starve later (e.g., during winter), because they

were unable to consume sufficient sustenance during summer to carry them over to the next feeding period (e.g., the following summer).

Also unknown are the distribution and abundance of spawning sites used by capelin in the Alaskan Arctic. The type of sandy gravel beach used by capelin occurs over much of the Beaufort Sea and Chukchi Sea coastline. Adverse effects on spawning aggregations of capelin are expected to be moderate at any beach location contacted by a large spill. Complete recovery of a spawning site to where there are no measurable impacts to fish would depend upon the persistence of oil in the environment and the sustainable use of the spawning location by capelin. It might require multiple generations before an affected spawning location produces a year class that successfully recruits into the adult population and helps the population recover to its former status.

Salmon. Pink and chum salmon are widely distributed over the northern Pacific Ocean and Bering Sea; they also occur to a lesser degree in arctic waters. Both chum and pink salmon runs exist in several coastal streams along the northeastern Chukchi Sea coast and pink salmon are the most abundant salmon species in the Beaufort Sea, although their abundance is negligible compared to waters in western and southern Alaska (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001). Pink salmon abundance generally increases from east to west along the Alaskan Beaufort Sea coast. Species-specific effects on chum and pink salmon are expected to be similar, so we describe pink salmon here.

Most pink salmon spawn within a few miles of the coast, and spawning within the intertidal zone or the mouth of streams is very common. Small spawning runs of pink salmon occur in the Sagavanirktok and Colville rivers, although not predictably from year to year. Available data suggest that pink salmon are more abundant in even-numbered years (e.g., 1978, 1982) than in odd-numbered years (e.g., 1975, 1983), as is the general pattern for this species in western Alaska (Craig and Halderson, 1986, citing Heard, 1986). This pattern may be a manifestation of the distinctive life cycle of the pink salmon (i.e., they spawn at 2 years of age and die following spawning). Among the few pink salmon collected in the Sagavanirktok River and delta were several spawned-out adults. Bendock (1979) noted pink salmon spawning near the Itkillik River and at Umiat. Two male spawners were caught near Ocean Point just north of Nuiqsut (Fechhelm and Griffiths, 2001, citing McElderry and Craig, 1981). In recent years, “substantial numbers” of pink salmon have been taken near the Itkillik River as part of a fall subsistence fishery (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Pink salmon also are taken in the subsistence fisheries operating in the Chipp River and Elson Lagoon just to the east of Point Barrow (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Craig and Halderson (1986) propose that pink salmon spawn successfully and maintain small but viable populations in at least some arctic drainages; continued occurrences of pink salmon in arctic drainages indicates their suggestion is credible.

An oil spill impacting the Chukchi or Beaufort coasts may adversely impact spawning and/or rearing habitat used by pink salmon. An oil spill that contaminates intertidal spawning substrate likely would result in moderate adverse impacts that decrease the affected population’s abundance. Full recovery, where no measurable impacts are occurring, would depend on the persistence of oil and the degree of contamination in the spawning or rearing environment. Spawning adults and/or their progeny occupying the site of an oil spill may be extirpated as PAHs in weathered oil can be biologically available for long periods and be very toxic to sensitive life stages. If an oil spill were to contaminate a pink salmon-spawning area, few pre-emergent pink salmon may survive. The effects of oil exposure to free-swimming pink salmon fry might be lethal, or the effects might result in reduced fitness and long-term survival, potentially resulting in lower recruitment to the spawning population from those early life stages. If the contamination persists and suitable spawning areas are otherwise limited, the number of adults returning to their natal stream might not be quickly replaced to preoil-spill numbers. Recovery to preoil-spill productivity would require that the site be free of contamination and available for spawning and/or rearing. Straying and recolonization of suitable spawning areas by salmon from within a regional

population likely would play a role in the recovery of a spill-affected area. The loss of production from discreet spawning locations might have a moderate local effect, but the overall effect on the regional population of pink salmon would be minor or negligible.

Pink salmon populations at the site of an oil spill also may be adversely affected indirectly through effects on food sources, but these effects are extremely difficult to study or predict. Because no evidence suggests significant biomagnification of oil through trophic linkages (Varanasi and Malins, 1977; Cimato, 1980), adult fish may be little affected by tainted food. However, larval or juvenile salmon may be affected by decreased feeding opportunities, slower growth rates, and increased predation (Fig. 4.4.1.4-1).

4.4.1.4.1.6. Cumulative Effects from Global Forces. Because of the presence of commercially valuable and intensively managed fisheries, researchers in the northern Bering Sea have been able to document that the marine ecosystem is shifting away from one characterized by extensive seasonal ice cover, high water column and sediment carbon production, and a tight pelagic-benthic coupling of organic production. There have been noted reductions in and/or northerly shifting of benthic fish, shellfish, and invertebrate populations; increases in pelagic fish; reduction in sea ice; increase in air and ocean temperature; and increases in ocean acidification. Grebmeier et al. (2006) state that ecosystem changes now being observed in the northern Bering Sea should be expected to affect a much broader portion of the Pacific influenced sector of the Arctic Ocean.

In broad terms, the prevalent conditions currently experienced in the southern Bering Sea, where the benthic biomass is largely consumed by upper trophic level pelagic and demersal fish and by epifaunal invertebrates, can be expected to slowly shift northward in response to climate changes.

The better known fish resources (i.e., abundant species) can exhibit very large interannual fluctuations in distribution, abundance, and biomass (e.g., capelin, arctic cod, Pacific sand lance, Bering flounder). Climate change experienced in the past and apparently accelerating in arctic Alaska likely is altering the distribution and abundance of their respective populations from what was known from past surveys.

Because surveys of fish resources in the proposed lease areas in the northeastern Chukchi Sea and western Beaufort Sea have been sporadic over the years, changes in these areas' fish resources in response to climate change will be harder to quantify and describe. It is unknown if the distribution and abundance information gathered by the last surveys remains an accurate and precise description of arctic fish populations today.

Climate change can affect fish production (e.g., individuals and/or populations) through a variety of means (Loeng, 2005). Direct effects of temperature on the metabolism, growth, and distribution of fishes occur. Food-web effects also occur through changes in lower trophic-level production or in the abundance of predators, but such effects are difficult to predict. Fish-recruitment patterns are strongly influenced by oceanographic processes such as local wind patterns and mixing and by prey availability during early life stages. Recruitment success sometimes is affected by changes in the time of spawning, fecundity rates, survival rate of larvae, and food availability.

For example, a climate shift occurred in the Bering Sea in 1977, abruptly changing from a cool to a warm period (ACIA, 2004, 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and noncrustacean invertebrates. The species composition of seafloor organisms changed from being crab dominated to a more diverse assemblage of echinoderms, sponges, and other sea life. Historically high commercial catches of Pacific salmon occurred. The walleye pollock catch, which was at low levels in the 1960s and 1970s (2-6 million metric tons), has increased to levels >10 million metric tons for most years since 1980. Additional recent climate-related impacts observed in the Bering Sea's large marine ecosystem include significant

reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. While the Bering Sea fishery has become one of the world's largest, numbers of salmon have been far below expected levels, fish have been smaller than average, and their traditional migratory patterns appear to have been altered.

The Arctic Climate Impact Assessment (ACIA, 2004, 2005) concluded that:

- The southern limit of distribution for colder water species (e.g., Arctic cod) are anticipated to move northward. The distribution of more southerly species (e.g., from the Bering Sea) are anticipated to move northward. Timing and location of spawning and feeding migrations are anticipated to alter;
- Wind-driven advection patterns of larvae may be critical as well as a match/mismatch in the timing of zooplankton production and fish-larval production, thereby influencing productivity (e.g., population abundance and demography);
- Species composition and diversity will change: Pacific cod, herring, walleye pollock, and some flatfish are likely to move northward and become more abundant, while capelin, Arctic cod, and Greenland halibut will have a restricted range and decline in abundance.

The following patterns, can exhibit very large interannual fluctuations in distribution, abundance, and biomass are indicative of changing processes influencing fish-resource distribution, abundance, habitat areas, and demography in response to climatic warming in the Arctic:

- the Bering Sea ecosystem has undergone some significant ecosystem shifts as a result of climatic warming;
- that warming in Alaska and adjacent lands and waters apparently has increased in the last decade and continues to increase;
- that patterns of sea-ice cover in the region are changing (e.g., ACIA, 2004, 2005), thereby influencing aquatic habitats;
- that the conclusions noted by the ACIA (see above) likely have been in action for one or more decades;
- the recent evidence of changing species distributions (i.e., new northern range limits of several fish species better known from the Bering Sea) in the Chukchi Sea as presented by RUSALCA ichthyologists.

Adjustments by one or more fish populations often require adjustments within or among large marine ecosystems, influencing the distribution and/or abundance of competitors, prey, and predators. Consequently, it appears reasonable to believe that the composition, distribution, and abundance of fish resources in the Beaufort and Chukchi seas are changing and are now different from that measured in the surveys conducted 16-18 years ago or earlier. The magnitude of these differences is unknown.

The occurrence of pink and chum salmon in arctic waters probably is due to their relative tolerance of cold water temperatures and their predominantly marine life cycle (Craig and Halderson, 1986, citing Salonius, 1973). The expansion of chinook, sockeye, and coho salmon into the Arctic appears restricted by cold water temperatures, particularly in freshwater environments (Craig and Halderson, 1986). Babaluk et al. (2000) noted that significant temperature increases in arctic areas as a result of climate change may result in greater numbers of Pacific salmon in arctic regions. The recent range extensions of pink, sockeye, and chum salmon in the Canadian Arctic, as described by Babaluk et al. (2000), indicate that some Pacific salmon may be expanding their distribution and abundance in the proposed project area.

4.4.1.4.2. Mitigation Measures. Lease stipulations and Information to Lessee (ITL) clauses used in the previous Beaufort Sea lease sales 186, 195, and 202 included mitigation measures to help protect fish resources in the Beaufort Sea (USDOI, MMS, 2003a).

State and local mitigation measures would also help avoid or minimize adverse effects on fish resources. Some examples of State mitigation measures and advisories for oil and gas activities in or on all North Slope Areawide 2007 leased lands and waterbodies as a condition of the approval of plans of operation (http://www.dog.dnr.state.ak.us/oil/products/publications/northslope/nsaw2007/ns_2007_mits.pdf). Geophysical exploration activities on state lands are governed by 11 AAC 96.

1. General Measures

3. a. Removal of water from fishbearing rivers, streams, and natural lakes shall be subject to prior written approval by DMWM and ADF&G.
- b. Removal of snow cover from fishbearing rivers, streams, and natural lakes shall be subject to prior written approval by ADF&G. Compaction of snow cover overlying fishbearing waterbodies will be prohibited except for approved crossings. If ice thickness is not sufficient to facilitate a crossing, ice and/or snow bridges may be required.
4. Water intake pipes used to remove water from fishbearing waterbodies must be surrounded by a screened enclosure to prevent fish entrainment and impingement. Screen mesh size shall not exceed 0.04 inches unless another size has been approved by ADF&G. The maximum water velocity at the surface of the screen enclosure may be no greater than 0.1 foot per second.

2. Facilities and Structures

5. Lessees must minimize the impact of industrial development on key wetlands. Key wetlands are those wetlands that are important to fish, waterfowl, and shorebirds because of their high value or scarcity in the region. Lessees must identify on a map or aerial photograph the largest surface area, including future expansion areas, within which a facility is to be sited or an activity is to occur. The map or photograph must accompany the plan of operations. DO&G will consult with ADF&G to identify the least sensitive areas within the area of interest. To minimize impacts, the lessee must avoid sitting facilities in the identified sensitive habitat areas, unless no feasible and prudent alternative exists.

3. Gravel Mining and Use

9. Gravel mining sites required for exploration and development activities will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage. Where feasible and prudent, gravel sites must be designed and constructed to function as water reservoirs for future use. Gravel mine sites required for exploration activities must not be located within an active floodplain of a watercourse unless the director, DL, after consultation with ADF&G, determines that there is no feasible and prudent alternative, or that a floodplain site would enhance fish and wildlife habitat after mining operations are completed and the site is closed.

4.4.1.4.3. Anticipated Level of Effects Under Alternative 1.

Effects Definitions and Levels. The basic unit of assessment is the metapopulation. A metapopulation consists of a group of spatially separated populations of the same species which interact at some level. A metapopulation is generally considered to consist of several distinct populations together with areas of suitable habitat which are currently unoccupied. Although individual populations have finite life-spans, the metapopulation as a whole is often stable because immigrants from one population (which may, for example, be experiencing a population boom) are likely to re-colonize habitat which has

been left open by the extinction of another population. Immigrants may also join a small population and rescue that population from extinction.

The following level of effect terms are used throughout the analysis of impacts on fish resources: negligible, minor, moderate, and major. These are defined as:

Negligible:

- No measurable impacts. Mortality is likely limited to a few individuals from a large metapopulation.
- Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year.
- Mitigation measures can be effectively implemented or are unnecessary.

Minor:

- Widespread annual or chronic disturbances or habitat effects that are not anticipated to accumulate across one year; or localized effects that are anticipated to persist for more than 1 year.
- Anticipated or potential mortality affects a localized aggregation estimated or measured in terms of hundreds or thousands of individual fish, but <1% of a region's metapopulation or <10% of a localized spawning population.
- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate:

- Impacts to the affected resource are unavoidable. Unmitigatable or unavoidable adverse effects are short-term but more widespread.
- Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year to up to a decade.
- Anticipated or potential mortality is estimated or measured in terms of tens of thousands of individuals or <20% of a local spawning population and <5% of a region's metapopulation, which may produce a short-term localized population-level effect.
- The viability of the affected metapopulation is not threatened although some localized impacts may be irreversible without mitigation or remedial action. The local population would recover completely if proper mitigation is applied during the life of the Proposed Action or proper remedial action is taken once the impacting agent is eliminated.

Major:

- Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer.
- Anticipated or potential mortality is estimated or measured in terms of hundreds of thousands of individuals or >20% of the local spawning population or >10% of a region's metapopulation, which could produce a long-term population-level effect.
- Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are widespread and long-lasting.

4.4.1.4.3.1. Direct and Indirect Effects under Alternative 1. There would be no direct or indirect impacts to fish resources in the project area from Lease Sales 209 or 217 if the lease sales were not held. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.4.3.2. Cumulative Effects under Alternative 1.

This section describes the impact on fish resources resulting past, present, and reasonably foreseeable future actions, without the proposed Beaufort Sea lease sales, regardless of what agency or person undertakes such other actions. There would be no incremental contribution to cumulative effects from Alternative 1. Past and present actions are described in Section 3 regarding how they affect fish resources. Reasonably foreseeable future actions are described in Section 4.2. The mitigation measures (Section 4.4.1.4.2) are considered in determining the anticipated effects from this alternative.

Summary. Existing impacts to fish resources from underwater noise and habitat loss are anticipated to continue to at no more than a minor level of effect. Existing state and Federal leases in the project area would continue to be explored with seismic survey and possibly, exploratory drilling, as well as other ancillary activities. Oil resources could be developed, although this is considered speculative. Spills, particularly in nearshore areas or at river crossings, pose a risk to fish resources. Oil spills from marine vessels or the oil and gas industry are considered high effect, low likelihood events. Transfer of bulk fuel to coastal communities poses the greatest risk of a large noncrude oil spill in the marine environment.

The changing climate could positively or negatively affect the distribution or abundance of numerous marine and freshwater species. Continuing climate change will lead to the loss or alteration of habitats important to fish resources and to changes in biological communities. Changes in the physical environment also may serve to promote increased vessel traffic in the Arctic, especially in the form of tourism or cargo shipping, thereby increasing the chance of vessel accidents, groundings, and spills. Selecting Alternative 1 is anticipated to result in a minor cumulative level of effect on fish resources in the Proposed Action area, with the exception of changes in the physical environment, which could have a major level of effect on fish resources.

4.4.1.4.3.2.1. Anticipated Level of Effect from Underwater Noise. Underwater noise is generated by vessel traffic, seismic surveys, and exploration or production drilling for oil and gas resources.

4.4.1.4.3.2.1.1. Vessel Noise. The potential effects on fish resources from vessel noise were described in Section 4.4.1.4.1.1.1. Vessel traffic is chiefly during ice-free conditions. Vessels (and associated noise) are transient. Vessel traffic may disturb some fish resources and fish in the immediate vicinity of such vessels may avoid such noise perhaps by as much as several hundred meters away. These vessels support routine North Slope communities and several industries. Continued support of oil and gas exploration and development operations in the United States and Canada is anticipated. Over time, increasing vessel traffic from tourism and cargo operations could increase the number and size of typical vessels operating in this area.

The amount of vessel traffic associated with oil and gas activities on the Beaufort Sea OCS is anticipated to remain fairly constant as existing and potential future leases are explored and resources delineated.

Summary. The underwater noise produced from existing and increasing vessel traffic is anticipated to have no more than a minor level of effect on fish resources.

4.4.1.4.3.2.1.2. Seismic-Survey Noise. Seismic activities are used to locate and delineate potential oil and gas resources. Many fish species are likely to hear airgun sounds as far as 2.7-63 km (1.6-39 mi) from their source, depending on water depth. Fish responses to seismic sources are species specific and may differ according to the species' lifecycle, as described in Section 4.4.1.4.1.1.2. Immediate mortality

and physiological damage to eggs, larvae, and fry; adult; and juvenile marine fishes is unlikely to occur, unless the fish are present within 5 m of the sound source (although more likely 1 m).

The potential for physical damage is related to the characteristics of the sound wave, the species involved, life stage, distance from the airgun array, configuration of array, and the environmental conditions. Given that this most likely would occur to fish within very close proximity to the sound source, MMS anticipates any injury would be limited to a small number of adult and juvenile fish.

Behavioral changes to marine fish and invertebrates may include short-term balance problems; disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses. Some fishes may be displaced from suitable habitat for hours to weeks. Thresholds for typical behavioral effects to fish from airgun sources occur within the 160-dB to 200-dB range. While we cannot say with certainty the impacts of seismic surveys on fish feeding behavior, there is no present evidence that the behavioral impact of seismic surveys has a major effect on fish feeding, except perhaps in the immediate vicinity of an active survey vessel. Adverse effects to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized, and only a minor level of disturbance or displacement would occur.

There is relatively little information concerning the distribution and abundance of populations of rare arctic fish resources from which to determine whether exposure to seismic airgun emissions would result in a measurable decline in abundance and/or change in distribution. It is logical to assume that these species would experience the same types of behavioral impacts and, depending on their physiology and exposure level, have the same potential for harm as other fish species similarly situated.

Because of the paucity of studies in both the Chukchi and Beaufort seas, a review of the available science and management literature shows that, at present, there are no empirical data to document potential impacts from seismic surveys reaching a local population-level effect. Additionally, the experiments conducted to date have not contained adequate controls in place to allow us to predict the nature of a change or that any change would occur. Thus, existing information has not demonstrated that seismic surveys alone would result in major impacts to marine fish or related issues (e.g., impacts to migration and spawning, rare species, subsistence fishing).

Under the no-action alternative, anticipated seismic-survey activity in the Beaufort Sea likely could decrease over time as ongoing efforts to delineate oil and gas potential on existing leases and surrounding waters in the Beaufort Sea would continue, but surveys are completed or leases expire. We conclude that the potential for impacts to fish resources from seismic activity, with mitigation measures imposed, are expected to result in no more than a minor level of effect.

We also considered the issue of basing this assessment on limited or lacking information on specific fish resources in the Alaskan Arctic. A review of the available science and management literature shows that, at present, there are no empirical data to document potential impacts reaching a population-level effect, nor have the experiments conducted to date contained adequate controls in place to allow us to predict the nature of a change, or that any change would occur. The information that does exist has not demonstrated that seismic surveys would result in major impacts to marine fish or related issues (e.g., impacts to migration/spawning, rare species, subsistence fishing).

Summary. Based on a review of available scientific and fishery management literature, MMS has determined that ongoing seismic surveys, in some cases, could result in a minor level of effect to fish resources but, in most instances, impacts would have no more than a negligible level of effect.

4.4.1.4.3.2.1.3. Oil and Gas Exploration or Production Noise. Underwater noise is produced during exploratory and production drilling. If fishes were disturbed by underwater noise emitted from the drill rigs, similar to reactions described in Section 4.4.1.4.1.1.3, fish could move away from the source of the noise, effectively being displaced from a zone around the drill rig.

Noise-related disturbance effects to fish and direct loss or degradation of fish habitats likely would occur during construction in the marine environment (e.g., well sites, platform placement, pipeline trenching or burial) and at freshwater sites (pipeline and maintenance road construction). Exploration drilling could displace fish from the immediate vicinity of a drill site.

Summary. As new construction from additional production from the Beaufort Sea OCS is not reasonably foreseeable, adverse effects from construction or production noise are not anticipated. Exploration drilling could result in a minor level of effects on fish resources.

4.4.1.4.3.2.2. Anticipated Level of Effect from Habitat Loss. The potential effects that could result in fish habitat loss are described in Section 4.4.1.4.1.2. Fish habitat loss could occur from community and industrial development.

Community Development. Coastal communities along the Beaufort Sea are anticipated to continue to slowly expand and construct new private and facilities that include roads, airports, clinics, etc. These projects would fill or otherwise modify or degrade wetlands and associated fish habitats over the reasonably foreseeable future. The decision to not conduct the proposed lease sales would not affect these effects and community developments would continue to result in minor adverse effects on fish resources.

Industrial Development. The potential effects to fish resources from oil and gas exploration and development activity are described in Section 4.4.1.4.1.2.2. Because of ongoing oil and gas exploration and development activity on state and federal leases in the Beaufort Sea, adopting the no-action alternative and not conducting Lease Sales 209 and 217 could reduce, but not eliminate, the anticipated short-term level of effect these activities are having in the region. These developments are anticipated to continue to occasionally create turbidity from construction or drilling in nearshore areas. These developments would also continue to expand and “in-fill” currently unaltered freshwater wetland habitats on private and state lands that support or are considered fish habitat. Anchoring or cable deployments are anticipated to continue to have a minor effect on fish habitats. These activities are anticipated to continue to result in no more than minor effects on fish resources.

As exploration of previously issued leases continues, the habitat effects from exploration drill sites would be relatively small considering the amount of similar habitats available to fish in the marine environment. Exploration activities are anticipated to result in no more than a minor level of effect to fish resources.

Drilling of production wells, constructing production platforms, and pipeline placement, currently viewed as speculative, could result in a direct loss of seafloor habitats at the placement sites. Trenching and pipe laying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <165 ft (50 m). This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, would remain suspended for short amounts of time or be moved offsite into other areas. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway to protect it against shoreline erosion. The specific locations of these facilities are unknown but would be evaluated under a subsequent NEPA document and Essential Fish Habitat consultation to develop and implement mitigation measures to minimize loss or degradation of marine fish habitats.

While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected.

A postlandfall pipeline and associated maintenance road alignment would depend on a number of factors, including cost and distance and avoidance of wetlands and other sensitive bird and wildlife habitats, as dictated by Federal policy and law. These policies would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment- and erosion-control measures.

Summary. Overall, continued community and industrial development are anticipated to result in a minor level of effect to fish resources.

4.4.1.4.3.2.3. Anticipated Level of Effect from Petroleum Spills. The potential effects of petroleum spills on fish resources were described in Section 4.4.1.4.1.5. While spills can occur on land or in the marine environment, spills in the Arctic that occur in or reach the nearshore marine environment have the greatest potential to affect large numbers of fish. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during period of ice are more prone to an accident. For example, three vessels enroute to explore the Canadian Beaufort Sea for oil and gas resources became trapped in sea ice near Barrow in early August 2008 (ADN, 2008). The highest chance of spills of noncrude products occurs during fuel-transfer operations at the remote villages of the North Slope.

A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4. Other sources of petroleum spills include oil spills/toxics contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea, but these are modeled as having a low percent chance of occurring, and it is improbable that a major adverse level of effect to fish resources from these activities would occur.

Species-Specific Effects from Oil Spills.

Diadromous Fish. Because most diadromous fishes make spawning runs and outmigrations over a period of time, it is unlikely that an entire year-class would be lost as it moved toward a spawning stream or migrated out of a stream. Even if fish were held up because a delta area was contacted by oil, it is unlikely that the major river deltas would be entirely contacted, given the broad expanses of the deltas, outflow, and the estimated size of a $\geq 1,000$ bbl spill. The Mackenzie River Delta covers about 210 km of coastline, the Colville about 32 km, and the Sagavanirktok and Canning about 16 km each. It is most likely that few channels of these rivers would be affected and, thus, only a portion of the spawning run or a portion of the variously aged fish in a population would be affected.

Effects on diadromous species while they are dispersed in the nearshore zone are expected to be moderate. However, if they are contacted while concentrated or aggregated in delta regions, moderate to major effects are possible. Because oil spills are more likely to affect diadromous species while they are dispersed in the nearshore rather than during the shorter timeframe in which they are aggregated, a moderate level of effect on these species is anticipated.

Arctic Cod. Even though arctic cod are vulnerable to effects from oil spills because they have floating eggs, are cryopelagic, and prone to segregating into discrete size or age groups, one spill $\geq 1,000$ bbl is anticipated to result in a moderate level of effect on this species.

Marine Demersal Fish. Because some species have broad distributions in the proposed sale area, and effects of spills are expected to be relatively localized and unlikely to affect the deeper benthos, a moderate level of effect on the regional populations of demersal fishes is anticipated.

Marine Pelagic Fish. In general, a single spill $\geq 1,000$ bbl is not anticipated to exceed a moderate level of effect on pelagic fishes.

Capelin. A large spill is considered a low likelihood, high effect event. Should the oil spill subsequently impact the spawning substrates of the affected population, a major level of effect is likely. An oil spill could have a major level of effect on capelin or their progeny at a given spawning location; however the regional capelin population would likely experience no more than a minor level of effect.

Although leases have been issued and exploration efforts are ongoing, aside from the pending Liberty and existing Northstar developments, future production of oil or gas resources on the Beaufort Sea OCS presently remains speculative (Section 4.2). If development and production from prior lease sales were to occur, we assume that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. The Beaufort Sea Multiple Lease Sale EIS (USDOJ, MMS, 2003a) evaluated the risk of an oil spill occurring and affecting fish or contacting fish habitats in the Beaufort Sea. While this risk is still associated with the existing leased issued from sales 186, 195, and 202, production resulting from those leases remains speculative and large spills are considered a low likelihood, high effect event. A more current spill analysis is covered for the Proposed Action, Section 4.4.1.4.1.5. The potential for spills from pipelines or offshore production facilities to contact fish resources is greatest during the open-water season.

In the unlikely event of an offshore oil spill occurring and contacting the nearshore area, some marine and migratory fish may be harmed or killed. However, lethal effects on fish from oil spills are seldom observed outside of the laboratory environment. For this reason, relatively small oil spills are likely to have mostly sublethal effects on the affected marine and migratory fish. Juvenile fish (for example, arctic cod), which are common in the nearshore area during summer, or nearshore spawners (e.g., capelin) are among those most likely to be adversely affected. Some fish in the immediate area of a spill may be killed; however, it is not likely to have a measurable effect on marine and migratory fish populations. Recovery would be likely in 5-10 years. Oil-spill-cleanup activities are not likely to have more than a minor affect on fish populations. Small operational oil or fuel spills are not likely to contact fish habitat and, therefore, are not likely to affect fish.

It is likely that a population experiencing a moderate level of effect could undergo a decline that could require successful recruitment in the future for it to return to its former status. If contamination persists and effects are not mitigated over time, fewer juvenile fish are likely to survive, recruitment to the spawning population would be reduced, and the number of remaining adult fish might not be sufficient to sustain a localized spawning population.

4.4.1.4.3.2.4. Anticipated Level of Effect from Changes in the Physical Environment.

Global climate change is affecting and will continue to influence marine, estuarine, and freshwater fish resources. Data trends show global climate change effects include changes in fish distribution, abundance, foraging, and migrational patterns and increased oxygen consumption rates in fishes (Roessig et al, 2005). These trends are expected to continue.

Global climate change could benefit some fish species by making habitat in the Arctic more hospitable for feeding, overwintering, and reproduction. In contrast, cryopelagic species, including their prey, that are uniquely adapted to life in the Arctic may find climate changes to be extremely detrimental due to loss of habitat and prey and from increased competition and predation. Climate change already may be causing changes in the diversity and abundance of arctic fish species but, because of limited information on the status of many marine and freshwater species, these changes may not become evident for many years.

4.4.1.5. Essential Fish Habitat.

Summary. We determined that there would be no direct or indirect effects to EFH if the lease sales were not held. Marine and coastal areas of the North Slope are commonly perceived to be pristine environments, yet there are number of past actions, ongoing activities, and potential sources of harmful effects to EFH. Existing impacts to fish resources from underwater noise and habitat loss are anticipated to continue to at no more than a minor level of effect. Existing Federal leases in the project area would continue to be explored with seismic survey and possibly, exploratory drilling, as well as other ancillary activities. Oil resources could be developed, although this is considered speculative. Spills, particularly in nearshore areas or at river crossings, pose a risk to EFH. Oil spills from marine vessels or the oil and gas industry are considered high effect, low likelihood events. Transfer of bulk fuel to coastal communities poses the greatest risk of a large non-crude oil spill in the marine environment.

Continuing climate change would likely lead to a major level of effect on EFH, including the loss or alteration of biological communities or positive or negative effects on the distribution or abundance of numerous marine and freshwater species. For example, the changing climate could affect the current distribution or abundance of Pacific salmon and their prey. Adult salmon may become more common in arctic waters and straying salmon may colonize new spawning locations. Changes in the physical environment also may serve to promote increased vessel traffic in the Arctic, especially in the form of tourism or cargo shipping, thereby increasing the risk of vessel accidents, groundings and spills. Alternative 1 is anticipated to result in a minor cumulative level of effect on EFH in the Proposed Action area, with the exception of changes in the physical environment, which could have a major level of effect on fish resources.

As described in Section 3.3.3, large coastal and marine portions within or adjacent to the proposed Beaufort Sea lease sale area have been described as EFH for five species of Pacific salmon occurring in Alaska. Pacific salmon EFH along the Beaufort Sea coast also includes those freshwater streams, lakes, ponds, wetlands, and other waterbodies currently or historically accessible to salmon.

The following analysis describes the potential effects from a variety of existing sources to EFH. Next, we identify mitigation measures (Section 4.4.1.5.2) that could avoid or minimize some of these impacts. The anticipated effects of this alternative on EFH are in Section 4.4.1.5.3.

4.4.1.5.1. Potential Effects to Essential Fish Habitat. The principal sources of potential adverse effects to EFH in the Beaufort Sea lease sale area are (1) seismic surveys; (2) exploration and development activities; (3) petroleum spills; and (4) changes in the physical environment. The potential adverse effects to EFH from these sources remain consistent across the Beaufort Sea and Chukchi Sea lease-sale areas. As an organism is inextricably linked to its habitat, many of the potential effects to EFH are the same as those described in Fish Resources (Section 4.4.1.4), particularly in reference to Pacific salmon.

4.4.1.5.1.1. Potential Effects from Seismic-Survey Activity. Potential adverse effects of seismic-survey activities and noise from oil and gas exploration activities on fish resources are described in

Section 4.4.1.4.1.1.2 and 4.4.1.4.1.1.3 and are incorporated here by reference. Seismic-survey activity is associated with oil and gas exploration and development in State and Federal waters.

Relatively low numbers of salmon currently migrate through the Beaufort Sea or use adjacent anadromous streams for spawning. Airgun emissions from seismic surveys conducted in the Beaufort Sea lease sale area may ensnare Pacific salmon EFH. Seismic noise could cause short-term disturbances (<1 week in any one location) to EFH during exploration phases. Because a majority of lease-sale blocks are beyond the estuarine habitat, seismic noise primarily would affect the marine habitat, especially during exploration, making the immediate area around the seismic airgun array temporarily uninhabitable for sensitive species and displacing maturing fish.

Seismic airgun emissions extend into infrasound, sound below 20 Hertz (Hz). Juvenile salmonids display strong avoidance reactions to infrasound, and infrasound has been used as an effective acoustic barrier for downstream migrating Atlantic salmon (*Salmo salar*) smolts. Therefore, airgun emissions in nearshore waters may act to deflect or displace Pacific salmon fry from preferred habitat or to inadvertently herd salmon around in offshore waters. Deflection and displacement from suitable rearing and foraging habitat may adversely affect the survival of juvenile Pacific salmon and their subsequent recruitment to a breeding cohort. Adverse impacts such as displacement of Pacific salmon fry from preferred habitat areas in coastal waters of the lease sale area may increase their vulnerability to predation by other fishes. Because of their relative scarcity in the Arctic, few salmon could be expected to be found in close proximity to airgun surveys. Potential effects of seismic survey activities are localized and are considered temporary, and no more than minor adverse effects would be expected to occur to marine EFH.

4.4.1.5.1.2. Potential Effects from Exploration and Development.

4.4.1.4.1.2.1. Community Development. Development of coastal community facilities (e.g., roads, airports, public facilities) often destroy wetlands that support fish habitats or adversely affect ponds and lakes that support fish and fish habitats. Some of these activities are described in Sections 4.4.1.6.2.3.2.7 and 4.4.1.7.3.2.7.

4.4.1.4.1.2.2. Industrial Development. The primary industrial activity in the Alaskan Arctic consists of oil and gas development. Potential effects from oil and gas exploration and development activities may include effects from noise, turbidity, discharges of produced water and drilling wastes, and platform and pipeline construction. Potential impacts from oil spills to fish resources are discussed in Section 4.4.1.4.1.5 and to EFH in Section 4.4.1.5.1.3.

Noise impacts to fish resource are discussed in Section 4.4.1.4.1.1. Scientific evidence suggests that some species of fish may be displaced from or choose not to enter areas of intense underwater noise. In contrast to seismic surveys, in which the source vessel has an associated zone of noise influence that moves with it through an area, exploratory drilling places a noise source in one area for 30-90 days (or more), creating a potential stationary zone of displacement around the well site(s). If this zone was close to shore, a migration barrier or zone of displacement within important rearing habitats could develop. Negative effects are species-specific and could affect one age-class cohort per year. Noise effects are anticipated to be minor.

Physical and biological effects of drill wastes are discussed in Sections 4.4.1.4.1.3.1 and 4.4.1.4.1.3.2, respectively. Effects from drilling wastes, including drilling muds and cuttings are considered to have no more than a minor effect and would be temporary in duration. The bottom substrate may be altered and fish temporarily displaced during exploratory and development drilling. Recovery and recolonization would begin shortly after drilling waste discharges ceased.

Offshore developments could result in platforms and pipelines that are linked to existing onshore infrastructure. Trenching and pipe laying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <165 ft (50 m). This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, remains suspended for short amounts of time or be moved offsite into other areas. Winter water withdrawals for ice-road construction that reduce critical overwintering habitat could have a moderate effect on EFH. Water use is permitted by the State of Alaska, and regulations limit removals to 15% of any freshwater habitat in lakes >2 m deep. Placement of subsea pipelines and their landfall locations may create a temporary adverse effect to EFH from turbidity as a result of trenching and dredging. Suspended sediments may temporarily displace fish. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway protect it against shoreline erosion.

4.4.1.5.1.3. Potential Effects of Petroleum Spills. Oil-spill effects on EFH from activities associated with the exploration, development, and production of oil resources in the Beaufort Sea could come from seismic surveys and associated vessel traffic, drilling discharges, spills at offshore platforms or at shore facilities, and spills from pipelines.

Impacts to EFH from oil spills could arise from a large spill from a platform or a pipeline, chronic small-volume oil spills, and from subsequent cleanup activities. The effects of oil on fish, including salmon, are described previously under Section 4.4.1.4.1.5.1 and incorporated here by reference. The general effects of oil spills on EFH are described before assessing a large oil spill or chronic small-volume spills and cleanup activities.

4.4.1.5.1.3.1. General Effects from Oil Spills to Essential Fish Habitat. Oil spills pose a substantial long-term risk to EFH. Oiled areas of Prince William Sound still contain North Slope Alaska crude oil from the 1989 Exxon Valdez oil spill (EVOS), and oil trapped in sediments or protected beneath cobble-armored beaches continued to show little weathering after 10 years.

4.4.1.5.1.3.2. Potential Effects to Freshwater Habitats. The greatest likelihood for a spill to impact freshwater EFH would be from an onshore pipeline leak at a river crossing or otherwise adjacent to freshwater during the open-water season. Spills in the marine or nearshore environment would affect freshwater only to the high-tide or storm-surge reach. An onshore winter spill on ice probably would be detected and effectively cleaned up, resulting in little more than a negligible impact to EFH. In anadromous streams, depending on the timing, location, amount and type of oil spilled, the stream bank and bottom substrate could become contaminated and, without cleanup and remediation, trapped oil could persist in the environment for many years and continue to adversely affect salmon. Freshly spilled and residual oil could displace spawning adults from preferred streams or from preferred locations within streams. While salmon could spawn successfully in an oiled environment, their offspring could nevertheless suffer adverse lethal and sublethal effects from oil exposure. The mechanism by which persistent oil can affect salmon eggs is described in Section 4.4.1.4.1.1.4.

Pink and chum salmon begin their outmigration towards the ocean immediately after emergence. Feeding in the freshwater environment is minimal, especially for salmon spawned close to the ocean. Oil that enters flowing waters along the North Slope eventually will enter the estuary and marine environment.

4.4.1.5.1.3.3. Potential Effects to Estuarine Habitat. The 5-mi-wide band of estuary and nearshore habitat along the coast has a greater risk of receiving oil from a spill than does the freshwater habitat. Potential sources of spills include maritime traffic, especially barges transferring fuel to coastal communities, and offshore oil and gas development and production operations. Among the three habitat

types (freshwater, estuary, marine waters), adverse effects to salmon, as well as other species, are most likely to occur close to shore in the shallow estuarine zone, where outmigrating salmon begin feeding and adjusting their physiological regulatory mechanisms from freshwater to saltwater.

Because salmon smolt new to the estuarine environment frequently occupy the shallowest waters, for example, only a few centimeters deep for pink salmon (North Pacific Fisheries Management Council, 1997), they are more likely to encounter surface oil or oil that has been deposited and mixed into the substrate. In such situations, salmon can easily encounter oil droplets and ingest oiled prey. Juvenile salmon are unlikely to effectively avoid oil washing ashore or oil that is present in the shallow estuarine habitat. Provided spilled oil does not persist and continue to leach into the estuarine and nearshore environment, only 1 year of salmon production would be affected by a singular spill event. Tides in the Beaufort Sea have a relatively small range, so there is not a great deal of intertidal reaches within a given stream to provide spawning habitat similar to streams in Prince William Sound, conditions that favored placing spawning fish in close proximity to trapped crude oil from the EVOS. Because of the harsh winter conditions in arctic Alaska, the best spawning and rearing locations coincide with upwelling groundwater and springs in streams, upstream of the narrow intertidal zones.

4.4.1.5.1.3.4. Potential Effects to Marine Habitat. Marine waters have the greatest likelihood of receiving spilled oil. Adult salmon would be able to avoid spill affected waters but potentially could ingest oil-impacted prey. Juvenile salmon could be exposed through direct contact or through ingestion. In most instances, effects would be sublethal but could result in decreased growth and survival rates. One year of maturing salmon would be affected, and salmon populations would expect to recover.

4.4.1.5.1.4. Potential Effects from Climate Change. Climate change has the greatest potential to have major effects on EFH through alteration of habitat and through alteration of many species' abundance, diversity, and geographic distributions. The potential effects to fish resources from climate change are discussed in Section 4.4.1.4.1.6.

4.4.1.5.2. Mitigation Measures. Lease stipulations and Information to Lessee (ITL) clauses from previous Beaufort Sea lease sales 186, 195, and 202 would help protect sensitive biological resources during permitted seismic activities and exploration and drilling operations in the Beaufort Sea (USDOI, MMS 2003a).

4.4.1.5.3. Anticipated Effects under Alternative 1. The anticipated effects from alternative are divided into direct and indirect effects (Section 4.4.1.5.3.1) and cumulative effects (Section 4.4.1.5.3.2). The mitigation measures (identified above) are considered in determining the anticipated effects from this alternative.

4.4.1.5.3.1. Direct and Indirect Effects under Alternative 1. If Lease Sales 209 and 217 were not held, there would be no direct or indirect effects. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.5.3.2. Cumulative Effects under Alternative 1.

Summary. Existing impacts to fish resources from underwater noise and habitat loss are anticipated to continue to at no more than a minor level of effect. Existing Federal leases in the project area would continue to be explored with seismic survey and, possibly, exploratory drilling, as well as other ancillary activities. Oil resources could be developed, although this is considered speculative. Spills, particularly in nearshore areas or at river crossings, pose a risk to EFH. Oil spills from marine vessels or the oil and

gas industry are considered high effect, low likelihood events. Transfer of bulk fuel to coastal communities poses the greatest risk of a large, noncrude oil spill in the marine environment.

Continuing climate change would likely lead to a major level of effect on EFH, including the loss or alteration of biological communities or positive or negative effects on the distribution or abundance of numerous marine and freshwater species. For example, the changing climate could affect the current distribution or abundance of Pacific salmon and their prey. Adult salmon may become more common in arctic waters and straying salmon may colonize new spawning locations. Changes in the physical environment also may serve to promote increased vessel traffic in the Arctic, especially in the form of tourism or cargo shipping, thereby increasing the risk of vessel accidents, groundings and spills. Alternative 1 is anticipated to result in a minor cumulative level of effect on fish resources in the Proposed Action area, with the exception of changes in the physical environment, which could have a major level of effect on fish resources.

This section describes the anticipated effects on EFH resulting from the incremental impact of the action (which for this alternative is taking no action) and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions are described in Chapter 3. Reasonably foreseeable future actions are described in Section 4.2.1.

4.4.1.5.3.2.1. Anticipated Level of Effect from Seismic Surveys. Seismic activities are used to locate and delineate potential oil and gas resources. Under this alternative, seismic survey activity in the Beaufort Sea would likely be reduced, but not eliminated, as ongoing efforts to delineate oil and gas potential on existing state and federal leases in the Beaufort Sea would continue. The anticipated adverse effects to those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity in the Beaufort Sea would primarily be from temporary displacement by noise or physical disturbances to the sea floor from anchor and cable deployment and retrieval. No more than minor adverse effects to EFH in the Beaufort Sea are anticipated.

A review of the available science and management literature shows that, at present, there are no empirical data to document potential impacts to EFH that would result in indirect population-level effects to fish. MMS concludes that seismic surveys, with standard mitigation measures imposed, are expected to result in no more than minor impacts to EFH. Adverse impacts such as displacement of Pacific salmon fry from preferred habitat areas in coastal waters of the lease sale area may increase their vulnerability to predation by other fishes. Because of their relative scarcity in the Arctic, few salmon could be expected to be found in close proximity to airgun surveys. The potential effects of seismic survey activities are localized and are considered temporary, and no more than minor adverse effects to EFH would be expected to occur to marine EFH.

4.4.1.5.3.2.2. Anticipated Level of Effect from Exploration and Development. The potential effects to EFH from exploration and development activities are described in Section 4.4.1.5.1.2. The potential effects to fish resources from exploration and development activity are described in Section 4.4.1.4.1.3.

Community Development. Continued development of coastal community facilities (e.g., roads, airports, and other public or private facilities) have the potential to destroy wetlands that support fish habitats or adversely affect ponds and lakes that support fish and fish habitats. Some of these projects are described in Sections 4.4.1.6.2.3.2.7 and 4.4.1.7.3.2.7. While perhaps more extensive along the Beaufort coast compared to the Chukchi coast, these development activities could have greater adverse effects on EFH than ongoing exploration activities. Together these activities have no more than minor effects on EFH.

Industrial Development. Similar to community development, continued construction of on-going improvements to land-based infrastructure has the potential to destroy wetlands that support fish habitats or adversely affect ponds and lakes that support fish and fish habitats. Some of these activities are described in Sections 4.4.1.6.2.3.2.7 and 4.4.1.7.3.2.7.

Other oil and gas exploration and development activities in marine areas of the Beaufort Sea are on-going and would continue because numerous federal and state leases have been issued from previous sales. These activities may include generation of underwater noise and discharges of produced water and wastes from drilling operations. The present trend towards using disposal wells instead of discharges to the marine environment would help reduce any adverse effects of these discharges on EFH. Affected habitats would begin to be repopulated once the disturbance ceased.

Some future development and production of oil or gas resources on the Beaufort Sea OCS is considered reasonably foreseeable (Section 4.2.1). If development and production is proposed from these existing leases, production wells may have similar effects as exploration wells, but would remain for the duration of the production period. Production wells, production platforms, and pipelines could result in a direct loss of seafloor habitats in State and Federal waters. However, these sites are relatively small compared to the amount of similar habitats available to fish in the marine environment. Trenching and pipe laying would take place during the open-water season or during winter, when landfast ice has stabilized. Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <165 ft (50 m). This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, remains suspended for short amounts of time or be moved offsite into other areas. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway protect it against shoreline erosion. Adverse effects to EFH are possible from ice-road construction (and associated water use) during pipeline construction.

Adopting this alternative and not conducting Lease Sales 209 and 217 would reduce, but not eliminate, the anticipated level of these activities in the region. As previously issued leases are explored the overall effect to EFH are temporary and would be minor. A future development and production project could result in moderate effects, depending on its location and other specific details.

As previously issued Federal leases are explored, exploration wells would result in a direct loss of seafloor habitats at the placement sites. However, these sites are relatively small compared to the amount of similar habitats available to fish in the marine environment, and the overall effect to EFH would be minor and temporary in nature. As with potential developments on State lands, a future development and production project could result in moderate effects, depending on its location and other specific details. The specific locations of these facilities are unknown, but would be evaluated under a subsequent NEPA document and EFH consultation in an effort to minimize any adverse fish habitat loss or degradation.

4.4.1.5.3.2.3. Anticipated Level of Effect from Petroleum Spills. The potential effects of petroleum spills on fish resources, including salmon, are described in Section 4.4.1.4.1.5. While spills can occur on land or in the marine environment, spills in the Arctic that occur in or reach the nearshore marine and estuarine environments have the greatest potential to affect EFH. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during period of ice are more prone to an accident. The ADEC (2007) reports that the highest probability of spills of noncrude products occurs during the transfer

of bulk fuel at remote North Slope communities. As these would be accidental, illegal events, they cannot be predicted and are anticipated to have a negligible effect on EFH.

Other sources of petroleum spills include a well blow-out or other oil spills/toxics contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea, but these are modeled as having a low percent chance of occurring, and it is improbable that major adverse effects to EFH from these activities would occur. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4.

Federal leases have been issued and exploration efforts are ongoing; some future development of oil or gas resources on the Beaufort Sea OCS is anticipated (Section 4.2.1). If development and production from prior lease sales were to occur, we assume that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. While any spill in the marine environment by definition would contact EFH, the potential for spills from pipelines or offshore production facilities to contact nearshore EFH is greatest during the open-water season. The Beaufort Sea Sale 193 EIS (USDO, MMS, 2007d) contains an assessment of how a large spill could affect EFH. Due to small changes in the location and size of the new lease-sale area and environmental resource areas, this assessment has been updated for the Proposed Action in Section 4.4.2.5.3.1.3.

In the unlikely event of an offshore oil spill occurring and contacting nearshore EFH, juvenile or adult salmon may be harmed or killed through direct contact or by ingestion of oiled prey.

However, lethal effects on fish from oil spills are seldom observed outside of the laboratory environment. For this reason, relatively small oil spills into EFH are likely to have mostly sublethal effects on the affected marine and anadromous fish. Recovery of EFH following a spill would depend upon the type of oil spilled, the size of the spill and its persistence in the environment. Adverse effects to EFH could range from negligible to major because recovery could take anywhere from a few days from a small spill to many years in the case of a large crude oil spill. A major effect on EFH would not necessarily result in a commensurate effect on salmon or salmon populations.

Small operational oil or fuel spills are unlikely to contact EFH. Proper use of oil-spill-cleanup procedures are likely to have a minor, temporary effect on EFH and should help to hasten recovery of EFH to prespill conditions. A spill from MMS-authorized activity would be an accidental, illegal event that cannot be predicted and, based on industry spill history, is anticipated to have a negligible effect on EFH.

4.4.1.5.3.2.4. Anticipated Level of Effect from Changes in the Physical Environment.

Potential effects to fish resources from climate change (Section 4.4.1.4.1.6.) are linked to effects to EFH from climate change. Changes in ocean temperature and chemistry will affect primary and secondary productivity and will lead to shifts in the distribution and abundance of multiple fish species, including salmon. Physical and chemical changes to EFH could be relatively easy to measure and quantify over time. However, associated detrimental or beneficial changes to fish resources in the Beaufort Sea would be difficult to quantify because of limited information on the status of many marine and freshwater species in the Arctic. Changes in diversity, distribution, or abundance may not become evident for many years. Selecting this alternative would have no effect on the rate and degree of climate change being experienced in the Beaufort and Chukchi seas. Anthropogenic influences to climate change resulting from hydrocarbon consumption would remain unchanged; only the source of the hydrocarbons would change. Climate change is anticipated to have a major effect on EFH.

4.4.1.6. Threatened and Endangered Species.

4.4.1.6.1. Threatened and Endangered Whales.

Summary. The ESA-listed whales that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas and that potentially could be adversely affected by activities within these planning areas are the bowhead whale, fin whale, and humpback whale. Alternative 1 (No Lease Sale) would result in negligible to minor level cumulative effects from past, current, and anticipated activities (including existing OCS lease activity) on bowhead and humpback whales, and negligible level effects on fin whales in the Beaufort Sea. Sales 209 and 217 would not occur under the no-action alternative and, therefore, no effects would occur in addition to existing past, current, and anticipated cumulative effects.

The following analysis describes potential adverse effects to endangered whales from existing sources (Section 4.4.1.6.1.1), mitigation measures to avoid or minimize potential adverse effects to endangered whales (Section 4.4.1.6.1.2), and the resulting potential adverse effects with mitigation applied (the anticipated effects) (Section 4.4.1.6.1.3). Anticipated effects are applied to determine the effects of the no-action alternative on bowhead, fin, and humpback whales.

Effects Definitions and Levels. For purposes of analyses, the levels of effects for endangered cetaceans are defined as follows:

Negligible:

- Localized, short-term disturbance or habitat effect experienced during 1 season that is not anticipated to accumulate across 1 year.
- Population-level effects are not detectable.
- No mortality is anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Population-level effects are not detectable. Temporary, nonlethal adverse effects would affect some individuals (<1.0%).
- No mortality is anticipated.
- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigable or unavoidable adverse effects are short-term and localized.

Moderate:

- One-time events, widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year.
- Population-level effects from temporary, nonlethal adverse effects may be detectable.
- Anticipated or potential collective mortality above the subsistence quota is estimated or measured in terms of individuals or consisting of <0.25% of the bowhead whale population or <25% of a year-class cohort [calf cohort assuming 50% females]), which may produce a long-term population-level effect. For fin whales, collective mortality from human causes of <2.0% is a moderate-level effect. Note: percentages approximate the potential biological removal (PBR) level defined by NMFS as the as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor and, for bowhead whales, the percentage noted above is the PBR above the allowable harvest quota.

- Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are short-term but more widespread.

Major:

- One-time events, widespread annual or chronic disturbance or habitat effects experienced during one season that would be anticipated to persist for decades or longer.
- Anticipated or potential collective mortality above the subsistence quota is estimated or measured in terms of individuals or consisting of >0.25% of the bowhead whale population or >25% of a year-class cohort (calf crop assuming 50% females), which could produce a long-term population-level effect. For fin whales, a mortality of >2.0% is a major effect, as it exceeds the PBR allowable for recovery (see note). For humpback whales, any mortality from human causes is a major effect to the Western North Pacific stock. Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are widespread and long lasting.

4.4.1.6.1.1. Potential Effects to Threatened and Endangered Whales. Multiple pathways exist through which endangered whales (cetaceans), particularly bowhead whales, could be affected by human activities, including oil and gas exploration, development, production, and abandonment activities in the Beaufort Sea and Chukchi Sea Planning Areas. Principal sources of potential adverse effects in the Beaufort and Chukchi seas include:

- deep-penetration 2D/3D/4D seismic airgun noise;
- high-resolution seismic-survey airgun, bathymetric sonar, sparker, sub-bottom profiler, and similar technologies noise and disturbance;
- vessel traffic and noise and disturbance;
- aircraft traffic and noise and disturbance;
- drilling platform construction and operations noise and disturbance;
- production noise and disturbance;
- facilities abandonment noise and disturbance
- discharges;
- oil/fuel spills and cleanup;
- hunting (bowhead whales); and
- changes in the physical environment.

With the exception of hunting of bowhead whales, these activities can be associated with one or more of the exploration, development, production, and abandonment activities associated with oil and gas development as well as commercial shipping, commercial fishing, research, and recreation activities.

4.4.1.6.1.1.1. Potential Effects From Noise and Disturbance. Activities noted in Section 4.4.1.6.1.1, all may have a noise-component potential that potentially could affect endangered whales. One of the greatest concerns associated with the impacts of oil and gas exploration and development on marine mammals has to do with potential impacts of noise on their ability to function normally, and on their health. During OCS oil and gas pre- and postlease exploration, development, production, and abandonment activities, human-caused noise is transmitted through the air and through marine waters from a variety of sources. These sources include, but are not limited to, 2D/3D/4D seismic surveys; high-resolution seismic surveys; pipeline, offshore platform, and shore-based construction; drilling; production; platform abandonment; icebreaker and other ship, boat, and barge traffic; and helicopter and fixed-winged aircraft traffic.

Background on General Characteristics of Sound, Sound in the Marine Environment and sources of Sound in the Alaskan Arctic. Because of the importance of this issue, a background is provided in Sections 3.2.7 and 4.3.1.1.

General Background on Effects of Noise and Disturbance on Cetaceans. Marine mammals rely on sound to communicate, to find mates, to navigate, to orient, to detect predators, and to gain other information about their environment (Erbe and Farmer, 1998; Erbe et al., 1999; National Research Council [NRC], 2003, 2005). The scientific community generally agrees that hearing for cetaceans is an important sense (Richardson et al., 1995a,b; NRC, 2003, 2005; National Resources Defense Council [NRDC], 1999, 2005). Because of their reliance on hearing, there is an increasing concern about the impacts of proliferation of anthropogenic noise on marine mammals, especially cetaceans. The NMFS (Carretta et al., 2001) summarized that a habitat concern for all whales, and especially for baleen whales, is the increasing level of human-caused noise in the world's oceans.

Many factors exist that collectively determine whether or not potential effects of noise and disturbances on bowhead, humpback, or fin whales are adverse and likely to occur. For example, hearing (auditory) systems and perception are species specific and habitat dependent, and the fate of sound after it is produced also is habitat and, especially in the Arctic, season and weather dependent. Because of differences in bathymetry and seabed characteristics of sites throughout the Beaufort Sea and Chukchi Sea, the distances that sounds of various frequencies, intensities, and pressures will propagate, and the resulting effects such sounds could have also are expected to differ greatly among specific sites (e.g., among specific lease blocks that differ in seabed properties, bathymetry, and the amount of wave action). Thus, the exact location of any sound source will determine the fate of sound released at that site and, therefore, will affect the possibility of impact on threatened and endangered cetaceans in or near the area. The time of year such sound is released will determine whether there is potential for individuals of a species to be exposed to that sound.

Noise from various sources has been shown to affect many marine mammals in ways ranging from subtle behavioral and physiological impacts to fatal (Olesiuk et al., 1995; Richardson et al., 1995a; Kraus et al., 1997; NRC, 2003, 2005). Increased noise could: (1) interfere with communication among whales; (2) mask natural sounds important to whales; (3) physiologically damage whales; and, (4) alter normal whale behavior, such as avoiding important areas (such as feeding areas) or displacing a migration route farther from shore.

Several important documents that summarize information on this topic include Richardson et al. (1995a); Hoffman (2002); Tasker et al. (1998); NRC (2003c, 2005); NRDC (1999, 2005); International Whaling Commission [IWC] (2004a). Two particularly relevant summaries by the NRC have occurred within the last few years: *Ocean Noise and Marine Mammals* (NRC, 2003c) and *Marine Mammal Populations and Ocean Noise, Determining when Noise Causes Biologically Significant Effects* (NRC, 2005). The MMC Advisory Committee on Acoustic Impacts on Marine Mammals, produced a report to the MMC (February 2006 – *The Advisory Committee on Acoustic Impacts on Marine Mammals Report to the MMC, Feb. 1, 2006*) detailing the views of six caucuses (available on their website at <http://www.mmc.gov/sound/> and in hard copy).

Southall et al. (2007) recommend criteria for injury (Permanent Threshold Shift or PTS) from exposure to a single pulse, expressed in terms of peak sound-pressure level (SPL), are Temporary Threshold Shift (TTS) onset levels plus 6 dB of additional exposure. Expressed in terms of sound-exposure level (SEL), the recommended criteria are TTS-onset levels plus 15 dB of additional exposure. They proposed injury criteria expressed both as SPL and SEL for individual low-frequency cetaceans, including humpback, fin, and bowhead whales, exposed to “discrete” noise events (either single or multiple exposures within a 24-

hour period) and multiple pulses. The proposed injury-criteria levels for pulses are SPL of 230 dB re 1 μPa (peak) (flat) and SEL of 198 dB re 1 μPa^2 . Proposed injury criteria for nonpulses are based on recommended SEL criteria for injury (PTS-onset are M-weighted exposures 20 dB higher than those required for TTS-onset. For all cetaceans exposed to nonpulses, the recommended SPL for injury is 230 dB re 1 μPa (peak) (flat) and SEL of 215 dB re 1 μPa^2 .

Southall et al. (2007) notes that for nonpulsed noise the combined information generally indicates no (or very limited) responses at Received Levels (RLs) 90-120 dB re 1 μPa and an increasing probability of avoidance and other behavioral effects in the 120-160 dB re 1 μPa range. However, these data indicated considerable variability in RLs associated with behavioral responses. Contextual variables (e.g., source proximity, novelty, operational features) appear to have been at least as important as exposure level in predicting response type and magnitude.

Results from several experimental studies have been published regarding sound-exposure metrics incorporating sound-pressure level and exposure duration. Investigators have also examined noise-induced TTSs in some odontocetes and pinnipeds exposed to moderate levels of underwater noise of various band widths and durations (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Kastak et al. (2005) summarized that:

Because exposure to...noise in the marine environment is sporadic and interrupted, it is necessary to examine variables associated with varying noise sound pressure levels, intermittence of exposure, and total acoustic energy of exposure, in order to accurately predict the effects of noise on marine mammal hearing.

While there is scientific acknowledgement of this statement, there are few instances where data are sufficient to evaluate the total energy exposure of a marine mammal from a given source. At present, we do not have the data necessary to make such a determination or understand how it might change our analysis.

Despite the increasing concern and attention, there still is uncertainty about the potential impacts of sound on marine mammals; on the factors that determine response and effects; and especially on the long-term, cumulative consequences of increasing noise in the world's oceans from multiple sources (NRC, 2003c, 2005). The NRC (2005) concluded that it is unknown how or in what cases responses of marine mammals to anthropogenic sound rise to the levels of biologically significant effects. This group also developed an approach of injury and behavioral "take equivalents." These take equivalents use a severity index that estimates the fraction of a take experienced by an individual animal. This severity index is higher if the activity could be causing harassment at a critical location or during a critical time (e.g., calving habitat). Because we have uncertainty about exactly where and how much activity will occur, the recommendations from the NRC (2005) are qualitatively incorporated in our analysis.

Available evidence indicates reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, previous experience, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary, depending on whether females have calves accompanying them or whether individuals are feeding or migrating. It may depend on whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates the ability, in a given situation, to predict the impacts of sound on a species or on classes of individuals within a species. Because of this, and following recommendations in McCauley et al. (2000), a protective approach is taken in our analyses and our conclusions about potential effects, and impacts are based on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums.

While there is some general information available, evaluation of the impacts of noise on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by the whales for different functions (Richardson et al., 1995a; Gordon et al., 1998; NRC, 2003c, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of the large whales or the impacts of sound on them, especially on them physically. While research in this area is increasing, it is likely that we will continue to have great uncertainty about physiological effects on baleen whales because of the difficulties in studying them. Baleen whale hearing has not been studied directly. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al., 1995a). Thus, predictions about probable impacts on baleen whales generally are based on assumptions about their hearing rather than actual studies of their hearing (Richardson et al., 1995a; Gordon et al., 1998; Ketten, 1998).

Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies <1,000 Hz. Bowhead whale songs can approach 4,000 Hz and calls can range between 50 and 400 Hz, with a few extending to 1,200 Hz (Richardson et al., 1995a). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1,000 Hz but can hear sounds up to a considerably higher but unknown frequency. At present, the lower and upper frequencies for functional hearing in mysticetes (baleen) whales collectively are estimated to be 7 Hz and 22 kHz (Ketten et al., 2007). The suspected vocalization frequency range for humpbacks varies from 10-3,700 Hz. Most baleen whale sounds are concentrated at frequencies <1 kHz, but humpbacks produce some signals with low level harmonics extending above 24 kHz. The presence of high-frequency harmonics does not necessarily indicate they are audible to the whales, but it does indicate high-frequency energy is present and may need to be reassessed as knowledge emerges.

Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1,000 Hz (Richardson et al., 1995a). Seismic airguns are meant to produce low-frequency noise, generally below 200 Hz. However, the impulsive nature of the collapse of air bubbles inevitably results in broadband sound characteristics. Good (1966, cited in Stone, 2001) reported that high-frequency noise also is produced and found significant levels of energy from airguns across bandwidth up to 22 kilohertz (kHz) (22,000 Hz). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al., 1995a). Bowhead whales, as well as blue and fin whales, are predicted to hear at frequencies as low as 10-15 Hz. McDonald, Hildebrand, and Webb (1995) summarize that many baleen whales produce loud low-frequency sounds underwater a significant part of the time. Thus, species that are likely to be impacted by low-frequency sound include baleen whales including the bowhead, fin, and humpback.

Most marine mammal species also have the ability to hear beyond their peak range. This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Ketten (1998:2) summarized that:

The consensus of the data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 500 Hz or higher. This statement refers solely to the probable potential for marine mammal species to hear sounds of various frequencies. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect. Other factors, such as sound intensity, will determine whether the specific sound reaches the ears of any given marine mammal.

Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson et al., 1995a,b; Ketten, 1998). Because of suspected differences in hearing sensitivity, it is likely that baleen whales and pinnipeds are more likely to be harmed by direct acoustic impact from low- to midsonic range devices than odontocetes (toothed whales). Conversely, odontocetes are more likely to be harmed by high-frequency sounds.

Little data are available about how, over the long term, most marine mammal species (especially large cetaceans) respond either behaviorally or physically to intense sound and to long-term increases in ambient noise levels. Large cetaceans cannot be easily examined after exposure to a particular sound source.

Whales often continue a certain activity (for example, feeding) even in the presence of airgun, drilling, or vessel noise. Such continuation of activity does not confirm that the noise is not harmful to the cetacean. In many or all cases, this may be true, it may not be harmful. However, this type of interpretation is speculative. Whales, other marine mammals, and even humans, sometimes continue with important behaviors even in the presence of potentially harmful noise. Whales often fast for long lengths of time during winter. The need to feed or to transit to feeding areas, for example, is possibly so great that they continue with the activity despite being harmed or bothered by the noise. For example, Native hunters reported to Huntington (2000) that beluga whales often ignore the approach of hunters when feeding, but at other times will attempt to avoid boats of hunters.

4.4.1.6.1.1.1. Potential Damage to Hearing. Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear's tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss to a marine mammal could result in an inability to communicate effectively with other members of its species, detect approaching predators or vessels, or echolocate (in the case of the toothed whales).

Hearing loss resulting from exposure to sound often is referred to as a threshold shift. Some studies have shown that following exposure to a sufficiently intense sound, marine mammals may exhibit an increased hearing threshold, a threshold shift, after the sound has ceased (Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Thus, a threshold shift indicates that the sound exposure resulted in hearing loss causing decreased sensitivity. This type of hearing loss is called a TTS if the individual recovers its pre-exposure sensitivity of hearing over time, or a PTS if it does not.

Ketten (1998) reported that whether or not a TTS or a PTS occurs will be determined primarily based on the extent of inner ear damage the received sound and the received sound level causes. In general, whether a given species will tend to be damaged by a given sound depends on the frequency-sensitivity of the species. Loss of sensitivity is centered on the peak spectra of the sound causing the damage.

Long-lasting increases in hearing thresholds, which also can be described as long-lasting impairment of hearing ability, could impair the ability of the affected marine mammal to hear important communication signals or to interpret auditory signals.

Most experiments have looked at the characteristics (e.g., intensity, frequency) of sounds at which TTS and permanent threshold shift occurred. However, while research on this issue is occurring, it is still uncertain what the impacts may be of repeated exposure to such sounds and whether the marine mammals would avoid such sounds after exposure, even if the exposure was causing temporary or permanent hearing damage, if they were sufficiently motivated to remain in the area (e.g., because of a concentrated food resource). There are no data on which to determine the kinds or intensities of sound that could cause a TTS in a baleen whale.

Permanent threshold shifts are less species-dependent and more dependent on the length of time the peak pressure lasts and the signal rise time. Usually, if exposure time is short, hearing sensitivity is recoverable. Hearing loss might be permanent if exposure to a sound is long, or if the sound is broadband in higher frequencies and has intense, sudden onset. Repeated long exposures to intense sound or sudden onset of intense sounds generally characterize sounds that cause PTS in humans. Ketten (1998) stated that age-related hearing loss in humans is related to the accumulation of PTS and TTS damage to the ear. Whether similar age-related damage occurs in cetaceans is unknown.

A very powerful sound at close range can cause death due to rupture and hemorrhage of tissues in lungs, ears, or other parts of the body. At greater distance, that same sound can cause temporary or permanent hearing loss. Noise can cause modification of an animal's behavior (e.g., approach or avoidance behavior, or startle).

Long-term impacts of OCS seismic-survey noise on the hearing abilities of individual marine mammals are unknown, and information about the hearing capabilities of large baleen whales is mostly lacking. As noted previously, the assumption is made that the area of greatest hearing sensitivity is at frequencies known to be used for intraspecific communication. However, because real knowledge of sound sensitivity is lacking, we believe it is prudent to assume in our analyses that sensitivities shown by one species of baleen whale also could apply to another. This reasonable approach provides the means to infer possible impacts on other species (such as the fin whale), especially when using studies on a species such as the humpback, which uses a large sound repertoire in intra-specific communication.

4.4.1.6.1.1.2. Potential Effects to Physiological Function. Nonauditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress (endocrine function, immune system, reproductive system, fight/flight response, etc.); neurological effects; bubble formation; resonance effects; and other types of organ or tissue damage. Traditional knowledge refers to “skittishness” as behavior reducing time spent at the surface thus decreasing availability of bowhead whales to Native subsistence hunters. There is no proof that any of these effects occur in baleen whales exposed to airgun-array noise, but there have been no direct studies of the potential sound from airguns to elicit any of the above effects. Romano et al. (2004:1131) identified neural immune measurements that may be “implicated as indicators of stress in the white whale and bottlenose dolphin that were either released acutely or changed over time during the experimental period.” Specifically, they found significant increases in aldosterone and a significant decrease in monocytes in a bottlenose dolphin after exposure to single impulsive sounds (up to 200 kilopascals (kPa) from a seismic watergun. Neural-immune changes following exposure to single pure tones (up to 201 dB re 1 μ Pa) resembling sonar pings were minimal, but changes were observed over time. A beluga whale exposed to single underwater impulses produced by a seismic watergun had significantly higher norepinephrine, dopamine, and epinephrine levels after high level sound exposure (> 100 kPa) as compared with low-level exposures (<100 kPa) or controls. Alkaline phosphatase decreased, but γ -glutamyltransferase increased over the experimental period. Most “fleeing” reactions in mammals are accompanied by endocrine changes that, depending on other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health.

Gas-filled structures in marine mammals have inherent fundamental resonance frequency. If stimulated, the ensuing resonance could cause damage to the animal. Diving marine mammals may be subject to decompression injury if they ascend unusually rapidly when exposed to aversive sounds; however, this interpretation remains unproven.

In summary, little is known about the potential for seismic-survey sounds to cause auditory impairment or other physical effect on marine mammals (LGL Ltd. environmental research associates, 2005).

Masking. When noise interferes with sounds used by marine mammals (e.g., interferes with their communication or echolocation), it is said to “mask” the sound (a call to another whale might be masked by an icebreaker operating at a certain distance away). Noises can cause the masking of sounds that marine mammals need to hear to function (Erbe et al., 1999). The presence of the masking noise can make it so that the animal cannot discern sounds of a given frequency and at a given level that it would be able to in the absence of the masking noise. If sounds used by the marine mammals are masked to the point where they cannot provide the individual with needed information, they can cause harm (Erbe and Farmer, 1998). In the presence of the masking noise, the sounds the animal needs to hear must be of greater intensity for it to be able to detect and to discern the information in the sound.

Erbe and Farmer (1998:1386) summarize that in “...the human and dolphin ear, low frequencies are more effective at masking high frequencies than vice versa; masking is maximized if the characteristic frequencies of the masker are similar to those of the signal...” They proposed that the factor most important for determining the masking effect of the noises was their temporal structure. The noise that was the most continuous with respect to frequency and time masked the beluga vocalization most effectively, whereas sounds (e.g., natural icebreaking noise) that occurred in sharp pulses that left quiet bands in between and left gaps through which the beluga could detect pieces of the call. In a given environment, then, the impact of a noise on cetacean detection of signals likely would be influenced by both the frequency and the temporal characteristics of the noise, its signal-to-noise ratio, and by the same characteristics of other sounds occurring in the same vicinity (e.g., a sound could be intermittent but contribute to masking if many intermittent noises were occurring).

It is not known whether (or which) marine mammals can (Erbe and Farmer, 1998) and do adapt their vocalizations to background noise. Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Species specific and individual differences would be expected from whales with differing communication behavior, sensitivity to ranges of sound frequencies, experience with noisy environments, and tolerances of noise to perform more dominant activities or behavior.

Behavioral Reactions. Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener’s sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary, depending on whether females have calves accompanying them, whether individuals are feeding or migrating (e.g., see discussion of impacts of noise on humpback whales in McCauley et al. [2000] and Section IV.B.1.f(3)(d)2) of the Cook Inlet multiple-sale EIS [USDOJ, MMS, 2003b]). Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability in a given situation to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, and following recommendations in McCauley et al. (2000), a proactive approach is taken in our analyses and our conclusions about potential affects and impacts are based on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums. This assumption may overestimate potential effects in many cases; however, because at least some of the airgun arrays being proposed for use in the Chukchi Sea and Beaufort Sea have greater total output than many of those in previous studies, we also may underestimate impact in some cases.

4.4.1.6.1.1.3. Potential Effects of 2D/3D/4D Seismic-Survey-Related Noise and Disturbance on Endangered Bowhead, Fin, and Humpback Whales. The 2006 Arctic Region Biological Evaluation (ARBE) (USDOJ, MMS, 2006c:Section IV.C.5.b) is incorporated by reference and provides a comprehensive discussion of potential effects of 2D/3D seismic surveys on bowhead whales.

Additional 3D surveys to determine reservoir status may occur during production phases of field development and would be 4D surveys as the repeated surveys introduce time as a dimension.

On-Ice Deep-Penetration 2D/3D Seismic Surveys. Bowhead, humpback, and fin whales would not be expected to occur in the Beaufort Sea or Chukchi Sea Planning Areas when on-ice 2D/3D seismic-survey operations would occur.

Open-Water Offshore Deep-Penetration 2D/3D/4D Seismic Surveys. Bowhead and humpback whales would be expected to occur in the Beaufort Sea when open-water 2D/3D/4D seismic survey operations would occur. Fin whales would not be expected to but may occur in the Beaufort Sea when such surveys would occur.

Offshore geophysical-exploration seismic surveys conducted in summer are sources of noise in the arctic marine environment. Airgun arrays are the most common source of seismic-survey noise. A typical full-scale array produces a source level of 248-255 dB re 1 μ Pa -m, zero to peak (Barger and Hamblen, 1980; Johnston and Cain, 1981). These surveys emit loud sounds that are pulsed rather than continuous and can propagate long distances (in some habitats, very long distances) from their source. However, most energy is directed downward, and the short duration of each pulse limits the total energy. Received levels within a few kilometers typically exceed 160 dB re 1 μ Pa (Richardson et al., 1995a) depending on water depth, bottom type, ice cover, etc. We provide a full description of typical 2D/3D seismic surveying operations in Appendix II of the 2006 ARBE.

Seismic surveys stay active as many days as possible. However, Fontana (2003) states: “On a very good survey we may be in shooting mode up to 40% of the time we are on site. Typically our shooting times average between 25% and 35%.” These shooting-time percentages are representative of the industry worldwide and appear to be applicable also to arctic Alaska waters; however, specific-operation shooting times can vary widely as a result of many variables. Thus, we anticipate that source vessels in the planning areas would not be operating continuously but rather would have periods when the airguns are silent.

In the Beaufort and Chukchi seas, we anticipate that the source vessels would be accompanied by at least one other vessel, which will be used for supplying and other needs, including refueling. In the case of operations anticipated in the Beaufort and Chukchi seas in 2008-2012, this vessel likely would be an ice-hardened vessel and classed as an icebreaker.

While the airgun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25-50 m deep, sound produced by airguns can be detected 50-75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995a). Sound produced by airguns can be detected by mysticetes and odontocetes that are from 10-100 km from the source (Greene and Richardson, 1988; Bowles et al., 1994; Richardson et al., 1995a) or potentially farther under some conditions.

It is unlikely there would be adverse effects from noise and disturbance associated with seismic-survey activities in the Beaufort Sea or Chukchi Sea planning area on fin whales because of their distance from such activities. No population impacts are plausible for fin whales, but effects on individuals could occur.

We do not rule out that fin whales feeding north of the Chukchi Peninsula could detect noise from seismic surveys, especially sounds from the 2D/3D seismic surveys that were occurring in the Chukchi Sea Planning Area. For purposes of analyses, we must assume that seismic surveys could occur anywhere throughout the Chukchi Sea and Beaufort Sea Planning Areas, because we have incomplete knowledge of

potential sound propagation in various locations and under specific conditions in these areas and, based on results from other studies in which seismic-survey sound has been detectable hundreds and even thousands of kilometers from the source.

Effects of such noise detection to fin whales, if such detection occurs at all and causes any response, are most likely to be short term and related to minor behavioral changes and, as a result, to be of negligible impact to the fin whale population. The long distances from activity where fin whales currently occur would render the received noise levels below noise-exposure-criteria levels that would cause injury or onset of significant behavioral response. The most likely potential effect, if fin whales hear some components of the seismic-survey noise, would be some increased attentiveness to the noise with a potential for slight modification of their attentiveness to other sounds, and possibly changes in their vocalizations.

Humpback whale observations during 2006 and 2007 in the western Beaufort and southern and eastern Chukchi Sea indicate the presence of this species in the planning areas during times that seismic-survey activities would be conducted. Assuming humpbacks continue to use habitats in the Beaufort Sea and Chukchi Sea Planning Areas, they likely would be affected by 2D/3D/4D seismic survey-related noise and disturbance as well as development, production, and abandonment activities.

Fin whales and humpback whales also might be exposed to noise from the seismic-survey vessels or support vessels as they transit to the Chukchi Sea in June and return as ice conditions dictate in the autumn. As noted, survey data indicate that humpback whales leave the most southern part of the Chukchi Sea, the northern part of the Gulf of Anadyr, prior to the start of ice formation (Mel'nikov, 2000). As vessels may be heading south to avoid the same ice, these vessels could overlap in time and space with whale movement.

Humpback whales likely would be exposed to noise from aircraft supporting exploration seismic-survey activities. Humpback and fin whales could be disturbed by aircraft noise associated with oil and gas leasing and exploration.

Potential Differential Responses of Male and Female Humpback Whales to Seismic Surveys. McCauley et al. (2000) recently demonstrated that pods of humpback whales containing cows involved in resting behavior in key habitat were more sensitive to airgun noise than males and than pods of migrating humpbacks. In 16 approach trials carried out in Exmouth Gulf off Australia, McCauley et al. (2000) summarized:

The generalized response of migrating humpback whales to a 3D seismic vessel was to take some avoidance maneuver at greater than 4 kilometers then to allow the seismic vessel to pass no closer than 3 kilometers. Humpback pods containing cows which were involved in resting behavior in key habitat types, as opposed to migrating animals, were more sensitive and showed an avoidance response estimated at 7-12 kilometers from a large seismic source.

McCauley et al. (2000) observed a startle response in one instance. Within the key habitat areas where resting females and females and calves occurred, the humpbacks showed high levels of sensitivity to the airgun. The mean airgun level at which avoidance was observed was 140 dB re 1 μ Pa (root-mean-square [rms]), the mean standoff range was 143 dB re 1 μ Pa (rms), and the startle response was observed at 112 dB re 1 μ Pa (rms). Standoff ranges were 1.22-4.4 km. The levels of noise at which a response was observed were considerably less than those published for gray and bowhead whales (see above). They also were less than those observed by McCauley et al. (2000) in observations made from the seismic-survey source vessel operating outside of the sensitive area where whales were migrating and not engaged

in a sensitive activity. Migration was not considered a sensitive activity in McCauley's study, although avoidance was noted. Humpbacks typically did not feed during the migration studied; however, resting areas and groups of nursing cows with calves were considered sensitive areas and activities. In Alaskan arctic waters, feeding, nursing, and resting might be considered sensitive activities as well as migration, especially in narrow corridors such as the Bering Strait. Information is lacking regarding sensitive areas in the Beaufort Sea and Chukchi Sea Planning Areas for humpbacks.

McCauley found that adult male humpbacks were much less sensitive to airgun noise than were females. At times, they approached the seismic-survey source vessel. McCauley et al. (2000) speculated that males that did so may have been attracted by the sound because of similarities between a single airgun signal and a whale-breaching event. Malme et al. (1985) noted in Southeast Alaska approaches by humpback whales to a single 100-cubic inch (in³) airgun source at ranges corresponding to sound exposure levels of up to 172 dB re 1 μ Pa (rms), but they did not speculate on sex or similarity of a single airgun noise and the potential attraction response to the sound to a breaching whale. Playback of recorded representative sounds of drillships, helicopter flyover, drilling platform, production platform, and semi-submersible drill rig were inconclusive. Based on the aforementioned, it is likely that humpback whales feeding or resting in areas within and adjacent to areas within the planning areas could have their movement and feeding behavior affected by noise associated with seismic surveys. The most likely to be impacted are females and calves. This potential impact would be seasonal, because humpbacks are present in these areas during the open-water period and absent when ice cover dominates.

Humpbacks make a variety of sounds. Their song is complex, with components ranging from <20 Hz-4 kHz, and occasionally up to 8 kHz. Songs can be detected by hydrophones up to 13-15 km. Songs can last as long as 30 minutes. They are typically heard on low-latitude wintering grounds and occasionally have been heard on northern feeding grounds (McSweeney et al., 1989). It is unlikely that seismic-survey noise would interfere with hearing these songs in the open-water season in the Chukchi and Beaufort seas. Humpbacks on high-latitude summer grounds are less vocal. Calls, clicks, and buzzes are made while feeding and may serve to manipulate prey and as "assembly calls" (Richardson et al., 1995a, USDOC, NOAA, 2007). These calls are at 20-2,000 Hz.

There are no studies that would indicate or not indicate differential responses to seismic surveys by different sex or age class, cow calf groups, or other groups or individuals fin whales at this time.

Summary of Effects of 2D/3D/4D Seismic Surveys. The observed response of bowhead whales to seismic noise has varied among studies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age. Feeding bowheads tend to show less avoidance of sound sources than do migrating bowheads. This tolerance should not be interpreted as a clear indication that they are not, or are, affected by the noise. Their motivation to remain feeding may outweigh any discomfort or normal response to leave the area. They could be suffering increased stress from staying where there is very loud noise. However, data on other species, and behavioral literature on other mammals, indicate that females with young are likely to show greater avoidance of noise and disturbance sources than will juvenile or adult males.

Recent monitoring studies (1996-1998) and traditional knowledge indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore shallow waters by a radius of about 20-30 km, with received sound levels of 116-135 dB re 1 μ Pa (rms). Some bowheads began avoidance at greater distances (35 km). Few bowheads approached the vessel within 20 km. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980s with 2D seismic activities. Avoidance did not persist beyond 12-24 hours after the end of seismic operations. In early studies, bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Available data indicate that behavioral

changes are temporary and nonlethal. However, there is concern within the subsistence whaling communities that whales exposed to this source of noise (and other sources) may become more sensitive, at least over the short term, to other noise sources. Research that tests or measures the nonlethal effects from repeated or long term exposure is not available for bowhead whales.

In summary of scientific studies and traditional knowledge presented above about the potential effect of 2D/3D seismic surveys on bowheads, bowhead response to 2D/3D/4D seismic surveys varies, sometimes considerably. It is not entirely clear which factor(s) explain the difference in response. However there is a consensus that migratory bowheads may avoid an active seismic source at 20-30 km (12.4-18.6 mi) in some circumstances; and deflection may start from even farther (35 km [21.75 mi]) and may persist 25-40 km (15.6-24.9 mi) to as much as 40-50 km (24.9-31.1 mi) after passing seismic-survey operations (Miller et al. 1999). Because data on other whales and other mammals indicate that females with calves may show even stronger avoidance, and because it often is unclear what behavior a whale was engaged in, we assume most individuals may avoid an active source vessel at received levels of as low as 116-135 dB re 1 μ Pa (rms) when migrating, but acknowledge this zone of avoidance may be considerably less for feeding whales. Richardson (1999) indicates the onset of significant behavioral disturbance for migrating bowheads from multiple pulses occurred at received levels around 120 dB re 1 μ Pa.

We conclude that fin whales could be adversely affected by seismic-survey-related noise activities in the Beaufort Sea or Chukchi Sea Planning Area on fin whales; however fin whales would not be expected to occur in the Beaufort Sea when such surveys would occur and very low numbers of fin whales may be exposed to seismic surveys in the Chukchi. No population level impacts are plausible for fin whales.

In summary of scientific studies presented above about the potential effect of 2D/3D/4D seismic surveys on humpback whales, response to 2D/3D/4D seismic surveys varies, sometimes considerably, and data are lacking in many cases. It is not entirely clear which factor(s) explain the difference in response. However there is a consensus that migratory humpbacks may avoid an active seismic-survey sound source at 4 km (2.5 mi). Data on other whales and other mammals indicate that females with calves may show even stronger avoidance with reaction. Humpback pods containing cows and calves that were involved in feeding and resting behavior in key habitat types, as opposed to migrating animals, were more sensitive and showed avoidance estimated at 7-12 km (4.4-7.5 mi) from a large seismic-survey sound source. The mean airgun level at which avoidance was observed was 140 dB re 1 μ Pa (rms), the mean standoff range was 143 dB re 1 μ Pa (rms), and a startle response was observed at 112 dB re 1 μ Pa (rms). Standoff distance ranges were 1.2-4.4 km (.75-2.7 mi).

Recent data have been published regarding measured versus modeled noise-level radii associated with different seismic-survey arrays in shallow and very deep water (Tolstoy et al., 2004) that indicate models may have been underestimating noise levels in shallow water. Because we explicitly assume that source surveys could occur anywhere within any portion of the Beaufort Sea Planning Area, as depicted in Figure 2-1; and because the characteristics of the surveys themselves are likely to vary from those undertaken previously in the planning area, we assume that the propagation characteristics also might vary from those determined during previous seismic-survey activities in the planning area. We summarize the information about noise levels at distances determined or estimated during previous studies in the Beaufort Sea and present and consider also the levels measured by Tolstoy et al. (2004).

Based on the best available information, we expect 2D/3D/4D and high-resolution seismic-survey activity in Federal waters of the Beaufort Sea over the next 5 years and longer if production occurs and 4D surveys are conducted. We expect this level of activity to be greater than that during the period of the previous 5 years (2003-2007). As detailed in the scenario section in Appendix II of the 2006 ARBE (USDOI, MMS, 2006c), new seismic-survey activity is expected to be mostly open-water 3D seismic surveys using streamers.

Potential Effects of Noise from High-Resolution Seismic Surveys. Bowheads appear to continue normal behavior when exposed to the noise generated by high-resolution seismic surveys. In the study by Richardson, Wells, and Wursig (1985), four controlled tests were conducted by firing a single 40 in³ (0.66-Liters [L]) airgun at a distance of 2-5 km (1.2-3.1 mi) from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3-5 km (1.86-3.1 mi) away (received noise levels at least 118-133 dB re 1 μ Pa rms). Some whales oriented away during an experiment at a range of 2-4.5 km (1.2-2.8 mi), and another experiment at a range of 0.2-1.2 km (0.12-0.75 mi) (received noise levels at least 124-131 and 124-134 dB, respectively). Frequencies of turns, pre-dive flexes, and fluke-out dives were similar with and without airguns; and surfacing and respiration variables and call rates did not change substantially during the experiments.

High-resolution seismic surveys are unlikely to have a biologically significant effect on endangered whales, especially bowhead whales, because high-resolution seismic surveys are of short duration and their airguns generate lower energy sounds and have a smaller zone of influence than 2D/3D surveys.

However, high-resolution seismic surveys conducted concurrently with 2D/3D seismic surveys and exploration/production drilling activities could cause local, adverse impacts, if large numbers of bowhead or humpback whales are present at the same time. A concentration of seismic-survey noise and other disturbance-producing factors may keep bowhead whales from high habitat value areas, especially if high-resolution seismic-survey activity were to operate inshore of 2D/3D seismic survey activities or drilling operations.

4.4.1.6.1.1.4. Potential Effects from Vessel and Aircraft Traffic and Noise. Vessel traffic and associated noise may be associated with exploration, development, production, and abandonment phases of oil and gas development as well as commercial fishing and shipping, research, recreation, subsistence hunting, and military activities. Bowhead, fin, and humpback whales primarily respond to vessel traffic and noise by avoidance. Vessels potentially could strike or entangle (with streamers, nets, gear) bowhead, humpback, or fin whales, causing injury or death. Potential effects of vessel traffic and noise depend on the size, propulsion systems, use, speed, and temporal/spatial relationships to endangered whales, their habitat, and other human activities.

4.4.1.6.1.1.4.1. Potential Effects of Noise from Icebreakers. Icebreakers may assist seismic-sound-source vessels and other vessels in transit to and from locations during ice conditions and support drillship operations and would be typical during late fall ice conditions. Additional disturbance and noise could be introduced by the icebreaker. Fin whales and humpback whales typically are not associated with ice conditions and likely would be absent from the Beaufort Sea Planning Area before ice-moving activities would occur.

Richardson et al. (1995a) reported that broadband (20-1,00 Hz) received levels at 0.37 km for the icebreaking supply vessel the *Canmar Supplier* underway in open water was 130 dB and 144 dB when it was breaking ice. The increase in noise during icebreaking apparently is due to propeller cavitation. Richardson et al. (1995a) summarized that icebreaking sound from the *Robert Lemeur* pushing on ice was detectable more than 50 km away. We anticipate that an icebreaker would attend a drillship in the Beaufort or Chukchi Sea. Brewer et al. (1993) reported that in fall 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by 25+ km. This ship was icebreaking almost daily. Richardson et al. (1995a) noted that in 1987, bowheads also avoided another drillship with little icebreaking.

If drillships are attended by icebreakers, as typically is the case during fall, the drillship noise frequently may be masked by icebreaker noise, which often is louder. Response distances would vary, depending on

icebreaker activities and sound-propagation conditions. Based on models in earlier studies, Miles, Malme, and Richardson (1987) predicted that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.24-15.53 mi) from the icebreakers. That study predicts roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2-12 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. The study also predicts that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson et al. (1995a:Table 6.5) provided source levels at 1 m for icebreaker noise. For example, they note that noise levels from the M/S *Voima* in open water at 50-60% power had broadband-noise levels of 177 dB re 1 μ Pa-m, whereas the source level when icebreaking full astern was 190 dB re 1 μ Pa-m.

Response distances of bowheads to icebreakers are expected to vary, depending on the size, engine power, and mechanical characteristics of the icebreaker, vessel activities, sound-propagation conditions, the types of individuals exposed, and the activities they are engaged in when exposed. Richardson et al. (1995b) found that bowheads migrating in the nearshore lead often tolerated exposure to projected icebreaker sounds at received levels up to 20 dB or more above the natural ambient noise levels at corresponding frequencies (average broadband ambient noise was 99 dB re 1 μ Pa and ambient noise level in the dominant 1/3 octave band centered at 80Hz was 76 dB re 1 μ Pa; this band had the dominant source level of icebreaker sounds). They pointed out that the source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in their study (median difference 34 dB over the frequency range 40-6,300 Hz). Over the 2-season period, they observed a difference in the estimated numbers of bowheads seen near the ice camp when the projects were quiet (approximately 158 bowheads in 116 groups) versus when icebreaker sounds were being transmitted into the water (an estimated 93 bowheads in 80 groups). Some but not all bowheads diverted from their course when exposed to levels of projected icebreaker sound >than 20 dB above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise and a minority of whales apparently diverted at a lower sound-to-noise ratio. The study concluded that exposure to a single playback of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable; however, for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km (31.1 mi). It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. For example, infrasounds that may be associated with icebreakers were not adequately represented in playback transmissions. Bowhead whales likely hear or can detect infrasounds (Richardson et al., 1995b).

Richardson et al. (1995b:322) summarized that:

The predicted typical radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least ± 10 dB around the “typical” threshold, with commensurate variability in predicted reaction radius.

Richardson et al. (1995b:xxi) stated that:

If bowheads react to an actual icebreaker at source to noise and RL values similar to those found during this study, they might commonly react at distances up to 10-50 km from the actual

icebreaker, depending on many variables. Predicted reaction distances around an actual icebreaker far exceed those around an actual drillsite...because of (a) the high source levels of icebreakers and (b) the better propagation of sound from an icebreaker operating in water depths 40+ m than from a bottom-founded platform in shallower water.

Richardson et al. (1995b:xxii) concluded that

...exposure to a single *playback* of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating bowheads visible in the open water of nearshore lead systems during spring migration east of Pt. Barrow. Reaction distances around an *actual icebreaker* like *Robert Lemeur* are predicted to be much greater, commonly on the order of 10-50 km. Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant.

4.4.1.6.1.1.4.2. Potential Effects from Other Vessel Traffic and Noise. Other vessel traffic and noise is associated with barges and support vessels related to oil and gas seismic, drilling, production and abandonment activities as well as other commercial barges, commercial fishing, research vessels, hunting activities, petroleum spill cleanup activities, cruise ships and military activity. Vessel traffic introduces noise as well as risk of endangered whale injury and death from collision, prop strike, and entanglement.

Bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. This avoidance may be related to the fact that bowheads have been commercially hunted within the lifetimes of some individuals within the population and they continue to be hunted for subsistence throughout many parts of their range. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3.1-4.3 mi), and a few whales may not react until the vessel is <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μ Pa) or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme, 1993).

In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of 2-4 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme, 1993). Vessel disturbance during these experimental conditions temporarily disrupted activities and sometimes disrupted social groups, when groups of whales scattered as a vessel approached. Reactions to slow-moving vessels, especially if they do not approach directly, are much less dramatic. Bowheads often are more tolerant of vessels moving slowly or in directions other than toward the whales. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. After some disturbance incidents, at least some bowheads returned to their original locations (Richardson and Malme, 1993). Some whales may exhibit subtle changes in their surfacing and blow cycles, while others appear to be unaffected. Bowheads actively engaged in social interactions or mating may be less responsive to vessels. Data are not sufficient to determine sex, age, or reproductive characteristics of response to vessels. We are not aware of data that would allow us to determine whether females with calves tend to show avoidance and scattering at a greater, lesser, or at the same distances as other segments of the population.

The encounter rate of bowhead whales with vessels associated with exploration would be determined on what areas were being explored. Bowhead whales probably would encounter relatively few vessels associated with exploration activities during their fall migration through the Alaskan Beaufort Sea. Vessel traffic generally would be limited to routes between the exploratory-drilling units and the shore

base. Each floating drilling unit probably would have one vessel remaining nearby for emergency use. Depending on ice conditions, floating drilling units may have two or more icebreaking vessels standing by to perform ice-management tasks. It is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, bowheads probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with exploration are not expected to disrupt the bowhead migration, and small deflections in individual bowhead-swimming paths and a reduction in use of possible bowhead-feeding areas near exploration units should not result in significant adverse effects on the species. During their spring migration (April through June), bowheads likely would encounter few, if any, vessels along their migration route, because ice at this time of year typically would be too thick for seismic-survey ships, drillships, and supply vessels to operate in.

In 2003 there was concern by Alaskan Native whalers that barge traffic associated with oil and gas activities might have caused bowhead whales to move farther offshore and, thus, to be less accessible to subsistence hunters. Greene (2003) concluded that a broadband source level of 171 dB re 1 μ P at 1 m is a reasonable and potentially a conservative (higher than the likely actual source level) estimate to use as a source level for the “relatively small tug and barge used by ConocoPhillips in its demobilization activities.” After evaluating alternative models for estimating transmission loss, and considering likely ambient noise levels (based on data collected in 1996 offshore of Northstar), Greene (2003) applied the estimated source level to what he viewed as the most reasonable sound propagation loss model to estimate the received level of sound at four distances (0.1-63 km) from the tug and barge. He estimated the following received sound levels at specific distances: 131 dB re 1 μ PA at 0.1 km; 111 dB re 1 μ PA at 1.0 km; 102 dB re 1 μ PA at 2.8 km; and 75 dB re 1 μ PA at 63 km. Given the assumptions that were required about hearing and the approximations regarding sound transmission loss, Greene (2003:4) stated it would be best to consider the estimates of received sound levels as “guidelines.”

Conoco Phillips also evaluated traditional knowledge information available from a 1997 workshop held in Barrow (Majors, 2004, pers. commun., as referenced in USDOJ, MMS, 2006b and NMFS, 2006). Based on this information, which is solely based on information from Conoco Phillips, they concluded that whales would have returned to their original headings about 45 mi before reaching Barrow if they had encountered noise from the barging operation at Camp Lonely. It is unclear exactly which information their conclusion it is based upon and there are no other data available to MMS regarding potential effects of the barge operations. Thus, we cannot critically evaluate the potential influence of the barging operations on whale movements near Barrow in 2003.

We are not aware of similar studies data regarding humpback and fin whale specific responses to vessel traffic and noise in the Arctic; however humpback and fin whales would be expected to be exposed to vessel traffic and noise in the Chukchi Sea and Beaufort Sea Planning Areas. We assume that these species responses may be similar to bowhead responses, but specific differences may be the case.

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead and humpback whales, causing injury or death. As noted in the baseline section of this evaluation, available information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not indicate that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality. Risk of strikes would increase as vessel traffic in bowhead and humpback habitat increases. Fin whales are not expected to occur in the Beaufort Sea.

4.4.1.6.1.1.4.3. Potential Effects from Aircraft Traffic. Most offshore Beaufort and Chukchi Sea aircraft traffic in support of OCS oil industry involves turbine helicopter straight line flights for personnel transport and fixed-wing aircraft engaged in monitoring activities. An example of potential

volume of traffic is indicated during the normal “open water period” in 2001 (June 16-October 31), there were approximately 989 roundtrip helicopter flights to Northstar. Various commercial passenger aircraft, recreational aircraft, research aircraft and industrial aircraft (transport and monitoring) use occurs offshore that is unrelated to OCS activities. There is no quantitative temporal or spatial accounting for these activities at this time. Underwater noise from aircraft is transient. According to Richardson et al. (1995a), the angle at which a line from the aircraft to the receiver intersects the waters surface is important. At angles greater than 13 degrees from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period that it passes overhead and is heard underwater. The helicopter noise measured underwater at depths of 3 and 18 m showed that noise consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Noise levels received underwater at 3 m from a Bell 212 flying overhead at 500 ft (152 m) ranged from 117-120 dB re 1 μ Pa in the 10-500-Hz band. Underwater noise levels at 18 m from a Bell 212 flying overhead at 500 ft (152) m ranged from 112-116 dB re 1 μ Pa in the 10-500-Hz band.

Data on reactions of bowheads to helicopters are limited. Most bowheads are unlikely to react significantly to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. Observations of bowhead whales exposed to helicopter overflights indicate that most bowheads exhibited no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). This noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Patenaude et al. (1997) found that most reactions by bowheads to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m (500 ft) or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. The majority of bowheads, however, showed no obvious reaction to single passes, even at those distances.

Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowheads (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60-460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of 182 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Information regarding aircraft noise, humpback behavior and important areas inhabited by humpback whales cow and calf groups in the Beaufort and Chukchi Planning areas is lacking. Humpback and fin whales could be disturbed by aircraft noise associated with oil and gas leasing and exploration. Based on their distributions and stock population sizes, humpbacks are more vulnerable to aircraft disturbance than fin whales. Shallenberger (1978) reported some humpbacks were disturbed by overflights at 1,000 ft (305 m), whereas others showed no response at 500 ft (152 m). As with response to airgun noise, pods varied in their response. Humpbacks in large groups showed little or no response, but some adult-only groups

exhibited avoidance (Herman et al., 1980). Due to concerns about the impacts of helicopters in Hawaiian waters, helicopters are prohibited from approaching within a slant range of 1,000 ft (305m) from humpbacks (NMFS, 1987). Currently, 1,500 ft (456 m) is the mitigation applied to industry-operational aircraft in the Chukchi Sea and Beaufort Sea Planning Areas, and this likely would be applied to seismic-survey monitoring flights to protect the suite of marine mammal species that could be encountered.

Fin whale distribution indicates a few individuals may occur within or immediately adjacent to the Chukchi planning area, but not the Beaufort planning area and, as such, a few individuals may be affected by noise and disturbance from aircraft traffic associated with seismic-survey activity in the Chukchi planning area.

While the obvious behavioral reaction of a bowhead or humpback whale to a single low-flying helicopter or fixed-winged aircraft flying overhead probably is temporary (Richardson et al., 1995a), most “fleeing” reactions in mammals are accompanied by endocrine changes, which, depending on the frequency and intensity of exposure and other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health. Such potential fleeing reactions likely would be considered in incidental take authorizations. Flight practices could be structured by the helicopter operators to avoid such interactions. Potential effects on bowheads from aircraft are relatively easily avoided by flight practices requiring fixed-wing flights above 456 m (1,500 ft) and avoidance by helicopters of areas where bowheads are aggregated and it is assumed similar practices would be applied to humpback and fin whales.

The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead, humpback or fin whales exists in areas where these whales are aggregated, especially if such aggregations contain large numbers of cow/calf pairs.

4.4.1.6.1.1.1.5. Potential Effects of Noise from Drilling Operations.

4.4.1.6.1.1.1.5.1. Potential Effects from Bottom-Founded Structure Placement and Drilling Operations. Two types of drilling platforms have been used for offshore drilling in the Alaska Beaufort Sea and may be used in the Chukchi Sea: the concrete island drilling system (CIDS), which is a floating concrete rig that is floated into place, ballasted with seawater, and sits on the seafloor; and the single steel drilling caisson (SSDC), which is a section of a ship with a drill rig mounted on it that is floated into place, ballasted with seawater, and sits on the seafloor. Artificially constructed gravel islands are a third platform used for drilling in the Beaufort Sea where shallow water allows. Drilling from these platforms can occur year-round; however, placement of platforms would occur during open-water periods for bottom-founded structures and winter for gravel islands.

4.4.1.6.1.1.1.5.2. Potential Effects of Noise from Construction and Placement of Gravel Island, Bottom-Founded Structures, and Platforms. Construction/placement activities could cause noise and disturbance to the bowhead and humpback whales in the Beaufort Sea Planning Area and likely would occur where feasible during exploration, development, and production activities. Information regarding humpback whale response to these activities is unknown in the Arctic, and it is assumed similar responses to that displayed by bowhead whales may occur. Placement of fill material for island construction generally occurs during the winter, when bowhead whales are not present. Completion of island construction, placement of slope-protection materials, and platform structures may take place during the open-water season, but these activities generally are completed before the bowhead whale fall migration. Placement of sheetpile, if used, would generate noise if done during the open-water period for one construction season, but also should be completed in early to mid-August, before the whales migrate. Noise is not likely to propagate far due to the shallow water and the presence of barrier

islands that, in some cases, may lie between the drilling location and the migration corridor used by bowhead whales, depending on location. Even during the migration, noise from these activities would be minor and would not affect bowhead whales. If such construction were to occur in an area where large numbers of whales were attempting to feed (such as has been observed in a few years (but not in many other years) in the Dease Inlet/Smith Bay area, the whales might be displaced from a small portion of the feeding range for that year.

Preliminary analysis of noise measurements during the open-water construction season at Northstar Island by Blackwell and Greene (2001) indicated that the presence of self-propelled barges had the largest impact on the level of sound coming from Northstar Island. Self-propelled barges remained at Northstar for days or weeks and always had their engines running, because they maintained their position by “pushing” against the island. Sound measurements on a day when there were no self-propelled barges showed that sounds were inaudible to the field acoustician listening to the hydrophone signal beyond 1.85 km (1.1 mi), even on a relatively calm day. By comparison, the sounds produced by self-propelled barges, while limited in their frequency range, were detectable underwater as far as 28 km (17.4 mi) north of the island. Other vessels, such as the crew boat and tugs, produced qualitatively the same types of sounds, but they were present intermittently, and their effect on the sound environment was lower.

4.4.1.6.1.1.5.3. Potential Effects of Noise from Drilling Gravel Island, Bottom-Founded Structures and Platforms. In the absence of drilling operations, radiated levels of underwater sound from the CIDS were low, at least at frequencies above 30 Hz. The overall received level was 109 dB re 1 μ Pa at 278 m, excluding any infrasonic components. When the CIDS was operating in early winter, radiated sound levels above 30 Hz again were relatively low (89 dB at 1.4 km). However, when infrasonic components were included, the received level was 112 dB at 1.4 km. More than 99% of the sound energy received was below 20 Hz. Received levels of sound at 222-259 m ranged from 121-124 dB. The maximum detection distance for infrasonic sounds was not determined. Such tones likely would attenuate rapidly in water shallow enough for a bottom-founded structure. Overall, the estimated source levels were low for the CIDS, even when the infrasonic tones were included (Richardson et al., 1995a).

Sounds from the SSDC were measured during drilling operations in water 15 m deep with 100% ice cover. The strongest underwater tone was at 5 Hz (119 dB re μ Pa) at a distance of 115 m. The 5-Hz tone apparently was not detectable at 715 m, but weak tones were present at 150-600 Hz. The broadband (20-1,000 Hz) received level at 215-315 m was 116-117 dB re μ Pa, higher than the 109 dB reported for the concrete island drilling system at 278 m.

Inupiat whalers believe that noise from drilling activities displace whales farther offshore, away from their traditional hunting areas. These concerns were expressed primarily for drilling activities from drillships with icebreaker support that were operating offshore in the main migration corridor. Concerns also have been expressed about noise generated from the SSDC, the drilling platform used to drill two wells on the Cabot Prospect east of Barrow in October 1990 and November 1991. Jacob Adams, Burton Rexford, Fred Kanayurak, and Van Edwardson, all with the Barrow Whaling Captain’s Association, stated in written testimony at the Arctic Seismic Synthesis and Mitigating Measures Workshop: “We are firmly convinced that noise from the Cabot drilling platform displaced whales from our traditional hunting area. This resulted in us having to go further offshore to find whales” (USDO, MMS, 1997).

The results of numerous acoustical studies at the Northstar production facility indicated that underwater sound produced from construction and oil-production activities attenuate rapidly and reach background levels within a few kilometers of the sound source (Blackwell and Greene 2001, 2006). Underwater sound propagation is affected by numerous factors including bathymetry, seafloor substrate, and water depth (Richardson et al. 1995a). Underwater sound propagation is reduced in locations where water is

shallow compared to deepwater locations. Underwater drilling noise could be audible up to 10 km during unusually calm periods (Greene and Moore, 1995). Blackwell et al. (2004) indicated underwater broadband sound levels from drilling Northstar reached background levels about 9.4 km from the island. McDonald et al. (2006) reported subtle offshore displacement of the southern edge of the bowhead whale migratory corridor offshore from Northstar Island.

Humpback and fin whale reactions to gravel island and bottom-founded drilling structure and their operation noise are unknown in the Arctic Ocean; however, it is assumed that reactions of these species would be similar to bowhead whale response although species specific differences may occur.

4.4.1.6.1.1.5.4. Potential Effects of Noise from Placement and Drilling from Drillships and other Floating Platforms. Drillships and other floating platforms have been used previously and may be used in the Beaufort and Chukchi Sea Planning Areas. Endangered whales could be affected by drillship and floating platform transit, placement and operation in the Beaufort and Chukchi Sea Planning Areas. Bowhead reaction to drillship operation noise is variable. Humpback and fin whale reactions to drillships are unknown in the Arctic Ocean; however, it is assumed that reactions of these species would be similar to bowhead whale response although species-specific differences may be expected. Bowhead whales whose behavior appeared normal have been observed on several occasions within 10-20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 km (0.12-3 mi) from drillships (Richardson et al., 1985a; Richardson and Malme, 1993). On several occasions, whales were well within the zone where drillship noise should be clearly detectable by them. In other cases, bowheads may avoid drillships and their support vessels at 20-30 km (see below and NMFS, 2003a). The presence of actively operating icebreakers in support of drilling operations introduces greater noise into the marine environment and responses of whales. The factors associated with the variability are not fully identified or understood.

Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by bowheads than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Most observations of bowheads tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event and this may suggest that bowheads will habituate to certain noises that they learn are nonthreatening. Additionally, it is not known what components of the population were observed around the drillship (e.g., adult or juvenile males, adult females, etc.).

The distance at which bowheads may react to drillships is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The principal finding of this study was that migrating bowheads appeared to avoid the offshore drilling operation in fall 1986. Thus, some bowheads may avoid noise from drillships at 20 km (12.4 mi) or more.

In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 km (2.48 mi) from operating drillships, well within the zones ensounded by drillship noise. The whales were not heading away from the drillship but were socializing, even though exposed to strong drillship noise. Eleven additional whales on three other occasions were observed at distances of 10-20 km (6.2-12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10-12 km (6.2-7.4 mi) and 18-19 km (11.2-11.8 mi), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988, as cited in Richardson and Malme, 1993) reported observations of bowheads within 0.2-5 km (0.12-3 mi) from drillships.

The ice-strengthened Kulluk, a specialized floating platform designed for arctic waters, was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the Kulluk indicated broadband source levels (10-10,000 Hz) during drilling and tripping were estimated to be 191 and 179 dB re μPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Richardson et al., 1995a).

Hall et al. (1994) conducted a site-specific monitoring program around the Kuvlum drilling site in the western portion of Camden Bay during the 1993 fall bowhead whale migration. Results of their analysis indicated that bowheads were moving through Camden Bay in a significantly nonrandom pattern but became more randomly distributed as they left Camden Bay and moved to the west. The results also indicated that whales were distributed farther offshore in the proximal survey grid (near the drill site) than in the distant survey grid (an area east of the drill site), which is similar to results from previous studies in this general area. The authors noted that information from previous studies indicated that bowheads routinely were present nearshore to the east of Barter Island and were less evident close to shore from Camden Bay to Harrison Bay (Moore and Reeves, as cited in Hall et al., 1994). The authors believed that industrial variables such as received level were insufficient as a single predictor variable to explain the 1993 offshore distribution of bowhead whales, and they suggested that water depth was the only variable that accounted for a significant portion of the variance in the model. They concluded that for 1993, water depth, received level, and longitude accounted for 85% of the variance in the offshore distribution of the whales. Based on their analyses, the authors concluded that the 1993 bowhead whale distribution fell within the parameters of previously recorded fall-migration distributions.

Davies (1997) used the data from the Hall et al. study in a Geographic Information System (GIS) model to analyze the distribution of fall-migrating bowheads in relation to an active drilling operation. He also concluded that the whales were not randomly distributed in the study area, and that they avoided the region surrounding the drill site at a range of approximately 20 km (12.4 mi). He noted that the whales were located significantly farther offshore and in significantly deeper water in the area of the drilling rig. As noted by Hall et al. (1994), the distribution of whales observed in the Camden Bay area is consistent with previous studies (Moore and Reeves, 1993), where whales were observed farther offshore in this portion of the Beaufort Sea than they were to the east of Barter Island. Davies concluded, as did Hall et al., that it was difficult to separate the effect of the drilling operation from other independent variables. The model identified distance from the drill rig and water depth as the two environmental factors that were most strongly associated with the observed distribution of bowheads in the study area. The Davies analysis, however, did not note that surface observers (Hall et al., 1994) observed whales much closer to the drilling unit and support vessels than did aerial observers. In one instance, a whale was observed approximately 400 m (436 yd) from the drill rig. Hall et al. suggest that bowheads, on several occasions, were closer to industrial activity than would be suggested by an examination of only aerial-survey data.

Schick and Urban (2000) also analyzed data from the Hall et al. study and tested the correlation between bowhead whale distribution and variables such as water depth, distance to shore, and distance to the drilling rig. The distribution of bowhead whales around the active drilling rig in 1993 was analyzed and the results indicated that whales were distributed farther from the drilling rig than they would be under a

random scenario. The area of avoidance was localized and temporary (Schick and Urban, 2000); Schick and Urban stated they could not conclude that noise from the drilling rig caused the low density near the rig, because they had no data on actual noise levels. They also noted that ice, an important variable, is missing from their model and that 1992 was a particularly heavy ice year. Because ice may be an important patterning variable for bowheads, Schick and Urban said they were precluded from drawing strong inference from the 1992 results with reference to the interaction between whales and the drilling rig. Moore and DeMaster (1998, as cited in Schick and Urban, 2002) proposed that migrating bowheads are often found farther offshore in heavy ice years because of an apparent lack of feeding opportunities. Schick and Urban (2002) stated that ultimately, the pattern in the 1992 data may be explained by the presence of ice rather than by the presence of the drilling rig.

In playback experiments, some bowheads showed a weak tendency to move away from the sound source at a level of drillship noise comparable to what would be present several kilometers from an actual drillship (Richardson and Malme, 1993). In one study, sounds recorded 130 m (426 ft) from the actual Karluk drill rig were used as the stimulus during disturbance test playbacks (Richardson et al., 1991). For the overall 20- to 1,000-Hz band, the average source level was 166 dB re 1 μ Pa in 1990 and 165 dB re 1 μ Pa in 1989. Bowheads continued to pass the projector while normal Karluk drilling sounds were projected. During the playback tests, the source level of sound was 166 dB re 1 μ Pa. One whale came within 110 m (360 ft) of the projector. Many whales came within 160-195 m (525-640 ft), where the received broadband (20-1,000 Hz) sound levels were about 135 dB re 1 μ Pa. That level was about 46 dB above the background ambient level in the 20- to 1,000-Hz band on that day. Bowhead movement patterns were strongly affected when they approached the operating projector. When bowheads still were several hundred meters away, most began to move to the far side of the lead from the projector, which did not happen during control periods while the projector was silent.

In a subsequent phase of this continuing study, Richardson et al. (1995b) concluded:

...migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nautical mile). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

Richardson et al. (1995b) reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB re 1 μ Pa rms broadband drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson and Greene, 1995).

Some migrating bowheads diverted their course enough to remain a few hundred meters to the side of the projector. Surfacing and respiration behavior, and the occurrence of turns during surfacings, were strongly affected out to 1 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2-4 km (1.25-2.5 mi). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant.

The authors stated that one of the main limitations of this study (during all 4 years) was the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. Both the Karluk rig and the icebreaker *Robert Lemeur* emitted strong sounds down to ~10-20 Hz, and quite likely at even lower frequencies. It is not known whether the under-representation of low-frequency components (<45 Hz) during icebreaker playbacks had significant effects on the responses by bowheads.

Bowheads presumably can hear sounds extending well below 45 Hz. It is suspected but not confirmed that their hearing extends into the infrasonic range below 20 Hz. The authors believed the projector adequately reproduced the overall 20- to 1,000-Hz level at distances beyond 100 m (109 yards [yd]), even though components below 80 Hz were under-represented. If bowheads are no more responsive to sound components at 20-80 Hz than to those above 80 Hz, then the playbacks provided a reasonable test of the responsiveness to components of Karluk sound above 20 Hz.

The authors also stated that the study was not designed to test the potential reactions of whales to nonacoustic stimuli detected via sight, olfaction, etc. At least in summer/autumn, responses of bowheads to actual dredges and drillships seem consistent with reactions to playbacks of recorded sounds from those same sites. Additional limitations of the playbacks identified by the authors included low sample sizes and the fact that responses were only evident if they could be seen or inferred based on surface observations. The numbers of bowhead whales observed during both playback and control conditions were low percentages of the total Beaufort Sea population. Also, differences between whale activities and behavior during playback versus control periods represent the incremental reactions when playbacks are added to a background of other activities associated with the research. Thus, playback results may somewhat understate the differences between truly undisturbed whales versus those exposed to playbacks.

In Canada, bowhead use of the main area of oil-industry operations within the bowhead range was low after the first few years of intensive offshore oil exploration in 1976 (Richardson, Wells, and Wursig, 1985), suggesting perhaps cumulative effects from repeated disturbance may have caused the whales to leave the area. In the absence of systematic data on bowhead summer distribution until several years after intensive industry operations began, it is arguable whether the changes in distribution in the early 1980s were greater than natural annual variations in distribution, such as responding to changes in the location of food sources. Ward and Pessah (1988) concluded that the available information from 1976-1985 and the historical whaling information do not support the suggestion of a trend for decreasing use of the industrial zone by bowheads as a result of oil and gas exploration activities. They concluded that the exclusion hypothesis is likely invalid.

4.4.1.6.1.1.6. Potential Effects of Noise From Oil and Gas Production Activities.

Production activities provide sources of effects from vessel and aircraft traffic, construction related facility maintenance, and work-over drilling activities discussed in preceding sections. Noise associated with producing and transferring products would occur year-round. As noted in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), it has been documented that bowhead and other whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (see summaries and references in Richardson et al., 1995a and NRC, 2003c). The monitoring of noise associated with the construction and production activities at the BPXA Northstar facility and the monitoring of marine mammals in nearby areas has recently provided additional information relative to assessing potential impacts of oil and gas production-related noise on bowhead whales. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea. However, the facility is situated in State of Alaska waters, and thus, is still nearshore relative to leasing blocks offered in the OCS lease sale. Two pipelines connect this island to the existing infrastructure at Prudhoe Bay. Oil production began on 31 October 2001 (Richardson and Williams, 2003).

North Slope residents have expressed concern that the bowhead whale autumn migration corridor might be deflected offshore in the Northstar area due to whales responding to underwater noise from construction, operation, and vessel and aircraft traffic associated with Northstar. Richardson and Williams (2004) and other researchers working with LGL and Greeneridge Sciences, Inc. undertook studies during the open-water period to determine both the underwater noise levels at various distances north of Northstar and potential impacts on bowhead whales north of the island, as assessed by locations

determined by vocalization locations. The final report confirms the basic findings previously referred to. Additional details from the final report are provided below.

Blackwell and Greene (2004:4-22) summarized that, in the absence of boats, “During both construction...and the drilling and production phase...island sounds...reached background values at distances of 2-4 km...” in quiet ambient conditions. Blackwell and Greene (2004) concluded that during the open-water season, vessels such as self-propelled barges, crew boats, and tugs (self-propelled barges) were the primary contributors to the underwater sound field. Broadband sounds from vessels near Northstar often were detected offshore as far as approximately 30 km. “Background levels were not reached in any of the open-water recordings with boats present at Northstar” (Blackwell and Greene, 2004:4-25). At Northstar in 2001, two 61.5-ft. (18.7-m) crew vessels operated between West Dock and Northstar between July 23, 2001, and October 7, 2001, for a total of 824 round trips (Williams and Rodrigues, 2003). Tone above 10 kHz characterized production sound. In-air sounds typically reached background levels at 1-4 km, but an 81-Hz tone was detectable 37 km from the island (Blackwell and Greene, 2004).

During 3 days in September 2001, Greeneridge Sciences collected measurements of underwater and airborne sounds at seven distances north of the island (0.25-37 km). The lowest levels recorded were 87-90 dB re 1 μ Pa underwater and 37-40 dB re 20 μ Pa in air at the most distant locations. Maximum levels were 116 dB re 1 μ Pa underwater and 56 dBA re 20 μ Pa in air. Richardson and Williams (2003) and Blackwell (2003) summarized that when both oil production and drilling was occurring, underwater and airborne sound reached background levels at about 3.5 km (2.2 mi.) from Northstar in quiet ambient conditions. The authors report that these values are comparable to those found in previous studies of sounds from gravel islands. Sound levels were higher (up to 128 dB re 1 μ Pa underwater at 3.7 km) when operating vessels, including crew boats, were present. Sound levels also were recorded from cabled hydrophones located about 0.25 nmi (420 m) north of Northstar continuously for 31 days from August 31 to October 1, 2002 (Richardson and Williams, 2003). Broadband (10-1,000 Hz) levels recorded in 2002 by the cabled hydrophones spanned a narrower range than in 2001. In 2001, the 95th percentile was higher (122.8 dB re 1 μ Pa) than in 2002 (117.2 db re 1 μ Pa), but the 5th percentile was higher in 2002 (94.8 dB) than in 2001 (87.8 dB). Median values were comparable in both years (2001:102. dB versus 2002:103.0 dB). Many spikes in broadband levels could be attributed to crew boats and barge traffic.

Richardson et al. (2004:8-2) summarized that data in 2001 provided evidence of a slight displacement of the “...southern edge of the bowhead whale migration corridor at times with high levels of industrial sound, but no such effect was evident in 2003, and the 2002 results were inconclusive.”

It is important to note that this study did not have a “Northstar-absent” control, a point noted by the authors of the report (see Greene et al., 2003:7-5). That is, there are no locations of whales based on vocalizations absent any sound from Northstar to be compared with localizations given Northstar sound. Limitations of the study are well discussed by the authors in the report. However, the available data on bowhead locations, coupled with data on noise propagation, indicate that if noise from Northstar is having an impact on whale movements, the effect, if it exists, is not dramatic.

4.4.1.6.1.1.7. Potential Effects of Noise from Facility Abandonment Activities.

Abandonment activities, in addition to vessel and aircraft support discussed previously, would include the use of explosives in demolition of exploration, delineation, development and production wells and facilities as necessary. Use of explosives is a potential source of noise, disturbance, and possible injury to threatened and endangered whale species. The casings for wells can be cut mechanically or with explosives during the process of well abandonment. The use of explosives could result in injury or even death to threatened and endangered marine mammals that are in the area at the time of the explosions. Underwater blasts can kill or injure marine mammals that are nearby. The threshold levels for injury or

death are not well established (for example, Ketten, Lien, and Todd, 1993; Richardson et al., 1995a). With respect to well abandonment, the MMS (USDOJ, MMS, Pacific OCS Region, 2001) previously summarized that:

...the use of explosives for delineation well abandonment would involve the detonation of a relatively small, 16- to 20-kilogram charge in the well casing 5 meters below the sea floor. This positioning of the charge would dampen the explosion and restrict shock and acoustic effects primarily to the area of water immediately above the well head. However, a marine mammal close to the detonation site potentially could be injured or killed, or suffer permanent or temporary hearing damage. Some disturbance of marine mammals present in the vicinity of the detonation area could also occur, but these would be expected to be minor and temporary.... Overall, impacts from this source are expected to be low.

Bowheads and humpbacks (and fin whales in the Chukchi Sea planning area) are the ESA-listed species under the jurisdiction of NMFS that may occur in areas where well-abandonment activities could take place. Available data indicate that whales are unlikely to occur within either the Beaufort Sea or Chukchi Sea Planning Areas or to occur close enough to be adversely affected by abandonment activity.

Impacts to endangered bowhead and humpback whales from well-abandonment activities could be avoided if these activities were implemented only when these whales were absent or if sufficient monitoring (e.g., aerial surveys and passive acoustic monitoring) for them occurred prior to the use of any explosives and protocols (e.g., a single mitigation gun deterrent procedure) were implemented to ensure that such explosives were not used if these species were in areas where a potential adverse impacts could occur.

4.4.1.6.1.1.1.8. Areas and Situations Where Potential Effects from Noise are Likely to be Greater than Typical. Bowhead, humpback, and fin whales are not randomly distributed throughout the Beaufort and Chukchi Sea Planning Areas. The extent of use of particular habitats varies among years, sometimes considerably. We cannot predict, in advance of a given year, exactly how bowheads will use the entire area that is available to them. Some aspects of their habitat use are poorly understood. For example, current data are not available on which to typify the current summer use of the northern Chukchi Sea by bowheads and even summer use of the Beaufort Sea is not well understood. For example, in some years, large aggregations of bowheads near Smith Bay have been observed during MMS' Bowhead Whale Aerial Survey Program (BWASP) surveys at the beginning of September. It is unclear if these animals are early migrants that have come from the east, if they summered in the northern portions of the Beaufort Sea and came south, or if they entered from the Chukchi Sea and never migrated east. It is unclear if these whales could be expected to be present in mid- to late-August. Observations of humpback and fin whales have occurred only in the open water seasons of 2006, 2007 and 2008 and are insufficient to determine habitat or distribution use patterns that would indicate areas or situations where effects from noise are likely to be greater than typical.

It is clear that if 2D/3D seismic surveys, vessel traffic, or drilling operations impacted areas of the spring lead and polynya system during the spring migration, impacts could be potentially biologically significant to bowhead whales. We note that the general location of the spring lead system in the Chukchi and Beaufort seas is based on relatively limited survey data and is not well defined. Noise-producing activities, such as seismic surveys, in the spring lead system during the spring bowhead migration have a fairly high potential of affecting the whales including females with newborn calves.

Data available from MMS' BWASP surveys over about a 27 year period indicate that, at least during the primary open water period during the autumn (when open-water seismic activities are most likely to

occur), there are areas where bowheads are much more likely to be encountered and where aggregations, including feeding aggregations and/or aggregations with large numbers of females and calves, are more likely to occur in the Beaufort Sea. Such areas include the areas north of Dease Inlet to Smith Bay, northeast of Smith Bay, and Northeast of Cape Halkett, as well as areas near Brownlow Point.

Such aggregations have been observed in multiple years during BWASP surveys. Groups of more than 50 or more whales have been seen on many single occasions (see data summarized in Treacy, 2002; Monnett and Treacy, 2005). For example, Treacy (1998) observed large feeding aggregations, including relatively large numbers of calves (for example, groups of 77[6], 62[5], 57[7], and 51[0], where the numbers given in brackets are the numbers of calves) of feeding bowheads in waters off of Dease Inlet/Smith Bay in 1997 and in 1998. However, in some years no large aggregations of bowheads were seen anywhere within the study area. When seen, the aggregations were in open water. As BWASP survey coverage is approximately 10% of the area surveyed, numbers counted are only a fraction of the numbers of whales that may be present.

If 2D/3D seismic surveys occurred in these areas when large aggregations were present, and particularly if multiple 2D/3D seismic surveys occurred concurrently in these areas, large numbers (hundreds) of bowheads could potentially be disturbed by the survey activity or could be excluded by avoidance from habitat for the period the surveys were occurring. As we explain in the description of the proposed action, the time frame over which 2D/3D seismic surveys are likely to occur in a given area is variable, depending on the size of the area being surveyed as well as the percentage of time when the boat is inactive. However, it would not be atypical for a seismic vessel to be in a given area for 20-30 days. Following the recommendation of the NRC (2005) regarding the expression of the length of period of a potential disturbance or behavioral impacts in migratory species be expressed in the context of how long the total period of potential use of the area is, we note that the period of just a single 3-D seismic survey could be half or more of the bowhead Beaufort Sea open water autumn migration/autumn feeding habitat use period. If another company or companies are interested in the same area (this is especially likely to occur in the Chukchi Sea evaluation area where there are no active leases) seismic survey activities could potentially exclude, through avoidance, bowhead whales from survey areas for the entire Beaufort Sea open-water autumn migration/autumn feeding period. We do not mean to infer that individual whales do, or do not, use some of these high use areas for this entire autumn open water period. Data are not sufficient to permit us to determine whether or not that is true. However, data do indicate that, in some cases either hundreds of whales could be excluded (through avoidance) from a large area for a relatively long portion of the season, or many more individuals would likely avoid the area as they sequentially came in to use the area.

A combination of sound sources of varying sound propagation characteristic could be operating simultaneously in the Beaufort Sea or Chukchi Sea. The number and distribution of drilling operations, 2D/3D deep penetration seismic surveys, high resolution surveys and associated support vessel and aircraft operations that may be operating concurrently in either the Beaufort or Chukchi Sea would be temporally and spatially in a state of constant change and unpredictable. Collectively these combinations and dynamics of operations would create an ever changing footprint of potential noise to which endangered whales could respond. The collective effects, depending on the size and shape of a noise footprint could create situations that can effectively impede movements; hold, trap, or influence whale movement patterns. Linear, open “V” or “U” shaped collective sound footprints can constrict and block movement or divert whales along migrations paths, trap whales in the “V” or “U” forcing whales to reverse direction in order to resume direction and activity, trap whales against shorelines, displace whales from or prevent access to important habitats, and a number of other scenarios could develop. Because this could occur, monitoring the dynamically changing area of avoidance and active and timely prevention of the development of such circumstances may require intensive open water management of operations or temporary shutdowns, as necessary to insure the free movement of whales in regard to

migration corridors, foraging area access and use, resting areas, and subsistence hunts. For example, multiple seismic vessels, the minimum separation of 15 mi that MMS requires compounded by operating drillship operations, multiple high resolution surveys and monitoring may not provide pathways through a linear or entrapment shaped whale avoidance area. Effects on endangered whales could be substantial when considering most bowhead whales will avoid approaching various sound sources such as an active seismic vessel or operating drill ships from a variable distances of up to 20-30 km (e.g., see study results provided above and summary in Appendix A of LGL Alaska Research Assoc. and LGL Ltd., environmental research associates, 2005), the distance exhibited by migrating bowhead whales in response to ocean-bottom cable (OBC) seismic surveys in the Alaskan Beaufort Sea at estimated received levels of about 116-135 dB re 1 μ Pa rms. We caution that this exercise is simply an attempt to gauge and approximate the extent and complexity of effects of the area that might be avoided. Because data indicate that bowhead reaction to sound source impacts varies, and could be lower in some cases if bowheads are in an area feeding (e.g., strong avoidance at ~3-7 km [1.9-4.4 mi]) (e.g., see Richardson et al., 1986; 1995a), but also could be higher during migration (e.g., up to 35 km [21.74 mi] in some cases). Given these assumptions, an instantaneous area being avoided by bowheads in all directions could be large and complicated by the shape of the avoided area and actual times of operational sound generation by each sound source. Arrangement must also be managed to prevent creation of a perpendicular blockade across major migration corridors. Conversely activities can be arranged to enhance movement of whales toward habitat or subsistence use areas as well. Multiple seismic-survey sound sources can provide for free movement of whales by maintaining distances between sound sources that allow for corridors of low noise between sound sources. This distance would be determined by the types and sound-verification patterns of each sound source. Multiple seismic-survey sources linearly arranged parallel to migration direction in the Beaufort or Chukchi Sea may allow for passage, as long as distances between parallel lines of surveys were far enough from each other to allow for reduced or near-ambient sound levels in corridors between lines of surveys or shore. These situations apply more specifically to bowhead whales but also may apply to humpbacks in the fall movement toward the Bering Strait. Existing information on movement patterns, migration corridors, and timing is not available to determine the nature of humpback fall movements out of the Arctic.

Monitoring and preventive actions would include consideration of any avoidance of support vessels or the attraction of prey that might be in the area. The “seismic fence” effect could be mitigated by requiring vessels and sound sources to be more distant from one another, but only if the distance allowed for noise-level reduced corridors through which whales would transit.

Such clumping of activities could occur, if different companies all were interested in a similar geological prospect and were spaced as near to one another as MMS requirements would allow. If restrictions were put on the number of operators that could operate simultaneously, within a single season, within a specified geographic area, the total area in the evaluation area excluded by avoidance would rise, but the simultaneous geographic impacts in a given area would be lessened. This potential strategy tradeoff could be important in reducing effects in high value areas.

We are aware that the extent of avoidance will vary both due to the actual noise-level radii around each sound source, the context in which it is heard, and the motivation of the animal to stay within the area. It also may vary depending on the age, and most likely, the sex and reproductive status of the whale. It may be related to whether subsistence hunting has begun and/or is ongoing.

Because the areas where large aggregations of whales have been observed during the autumn also are areas used, at least in some years, for feeding, it may be that the whales would show avoidance more similar to that observed in studies of whales on their summer feeding grounds. However, as we noted above, it is not clear that reduced avoidance should be interpreted as a reduction in impact. It may be that

bowheads are so highly motivated to stay on a feeding ground that they remain at noise levels that could, with long-term exposure, cause adverse effects.

We also acknowledge that effects could be greater than anticipated in two situations in the Chukchi Sea. The first situation could arise in the summer if bowheads use the Chukchi Sea in the summer more than is commonly assumed, especially for feeding and if large numbers of females with calves remain in the Chukchi Sea. Because recent data are not available on which to evaluate current habitat use by season or area in the Chukchi Sea, we cannot rule out potential for biologically significant effects in this evaluation area if sufficient mitigation is not imposed to shape the action. The second situation for larger than typical impacts probably exists in the Chukchi Sea in the autumn (e.g., late September on) as whales migrate both towards the Asian coast and toward the Bering Strait. We do not have sufficient data to determine the current migration paths or the numbers of whales that might be deflected from those paths. Data are not available to determine how intensively bowheads feed during the autumn migration in the Chukchi Sea or whether large aggregations exist in certain places due to prey resources.

We note that the potential for large numbers of individuals to be excluded by avoidance from a given area, or potentially impacted by higher levels of noise if feeding, could be avoided or substantially reduced by mitigation requiring site-specific monitoring in an area prior to initiation of seismic surveys, with specific restrictions on seismic surveys if certain abundance and age/sex classes of bowhead thresholds were exceeded. Large zones of potential avoidance could be reduced through mitigating measures that limited the number of active seismic vessels that could operate within a given area at any given time.

4.4.1.6.1.1.9. Potential Effect of Noise from Petroleum-Spill-Cleanup Activities. We acknowledge that petroleum spills associated with OCS oil and gas activities could occur. There could be localized, short-term alterations in bowhead, fin, and humpback habitat and habitat use as a result of cleanup noise and disturbance from a spill. Location, size, and timing of a spill and related complexities of cleanup operations would determine the degree to which endangered whales would be exposed to cleanup-operation noise. Whale exposure to petroleum spill-cleanup noise is further decreased as whales generally avoid noise related to vessel activities and, therefore, likely would not remain in the immediate area of a spill and would avoid the vessel activity, human activity, and noise associated with cleanup of such a spill. These conclusions are supported by the best available information.

Summary of Potential Effects of Noise and Disturbance Sources.

Bowhead Whales. Available information indicates that bowhead whales are responsive, in some cases highly responsive, to anthropogenic noise in their environment. We have reviewed available information above. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source and the reasons for this variability are not fully understood. In other species of mammals, including cetaceans, females with young are more responsive to noise and human disturbance than other segments of the population. Oil and gas exploration, development, and production could result in considerable increase in noise and disturbance in the spring, summer, and autumn range of the BCB Seas (Western Arctic stock) bowhead whales.

Depending on their timing, location, and number, these activities potentially could produce sufficient noise and disturbance that bowhead whales might avoid or be displaced from an area of high value to them and suffer consequences of biological significance. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by females and calves.

If multiple seismic and other noise-producing operations overlap in time, the zone of seismic exclusion or influence potentially could be quite large, depending on the number and the relative proximity to one another of the concurrent active sound sources. If noise sources and levels remain unmitigated, or are insufficiently mitigated to reduce impacts to the whales themselves, effects that are biologically significant could result if avoidance of feeding area, resting (including nursing) areas, or calving areas by large numbers of females with calves or females (including pregnant females) occurs over a period of many weeks, and they are not able to readily use other similar areas without a costly expenditure of energy. The impact to individuals likely would be related to the importance of the food source or resting area to the component of the population that would have used it, had not the disturbance caused them to avoid the area. This is likely to remain unknown. Potential impacts to the population would be related to the numbers and types of individuals that were affected (e.g., juveniles, mature males and non-reproductive females versus females with calves or pregnant females). Activities that cause active avoidance over large distances will have the effect of reducing rest areas bowheads (e.g., between hunting areas) have during their autumn migration and other uses of the Beaufort Sea.

The observed response of bowhead whales to seismic noise has varied among studies. The factors associated with variability are not entirely clear. However, data indicate that fall migrating bowheads show greater avoidance of active seismic vessels than do feeding bowheads. Recent monitoring studies (1996-1998) and traditional knowledge indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 km and may begin avoidance at greater distances. Received sound levels at 20 km ranged from 117-135 dB re 1 μ Pa rms and 107-126 dB re 1 μ Pa rms at 30 km. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980s. Avoidance did not persist beyond 12-24 hours after the end of seismic operations. In some early studies, bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Available data indicate that behavioral changes are temporary. The subsistence whaling communities are very concerned that whales exposed to this source of noise (and other sources) may become more sensitive, at least over the short term, to other noise sources.

Bowheads respond to drilling noise at different distances, depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km (6.2-12.4 mi) or possibly more. The response of bowhead whales to construction in high-use areas is unknown and is expected to vary with the site and the type of facility being constructed. Similarly, the long-term response of bowheads to production facilities other than gravel islands located at the southern portions of the migration corridor is unknown.

Exploration, development, and production results in an increase in marine-vessel activity and, depending on location and season, may include icebreakers, barges, tugs, supply and crew boats, and other vessels. Whales respond strongly to vessels directly approaching them. Avoidance of vessel usually begins when a rapidly approaching vessel is 1-4 km (0.6-2.5 mi) away, with a few whales possibly reacting at distances from 5-7 km (3.1-4.3). Received noise levels as low as 84 dB re 1 μ Pa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5). Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Icebreaker response distances vary. Predictions from models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.2-15.5 mi), with roughly half of the bowhead whales showing avoidance response to an icebreaker underway in open water at a range of 2-12 km (1.2-7.5 mi) when the sound-to-noise ratio is 30 dB, and roughly half of the bowhead whales showing avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.9-12.4 mi) when the sound-to-noise ratio is 30 dB.

Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

Exploration, development, and production also results in increased aircraft traffic, including possible whale-monitoring flights. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise. Bowheads are not affected much by any aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). The effects from such an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales should resume their normal activities within minutes. If numerous flights for exploration or development and production occur, depending on the location, bowheads may be repeatedly exposed to helicopter noise in areas between shore bases and/or airports and the production facilities. Depending on where shore bases for activities are located, effects could be mitigated by ensuring that flight paths avoided whale aggregations or that flights were high enough to avoid disturbance.

We anticipate that gravel islands are not likely to be constructed for exploratory drilling in OCS waters, but that old artificial islands might be used temporarily. In the near future, we expect that exploratory drilling in the Beaufort Sea also will be conducted from other platforms and during the open-water period, depending on water depth, sea-ice conditions, availability of drilling units, and the ice resistance of units. Moveable platforms resting on the seafloor could be used to drill in water depths of 10-20 m (33-67 ft), but that drillships or other floating units would be used in deeper water. Drilling from these units would be in open water. Such drilling would be supported by icebreakers and supply boats. This is expected to be the norm in the Chukchi Sea.

If gravel islands were used for exploration or production drilling, noise produced from drilling from gravel islands probably would not have large effects on bowhead whales, because gravel islands are constructed in fairly shallow water shoreward of the main migration route, and noise from operations on gravel islands generally is not audible beyond a few kilometers. In the Beaufort Sea, island-construction activities likely would be conducted during winter and generally in nearshore, shallow waters shoreward of the main bowhead whale migration route. However, as evidenced by Northstar, such construction was supported by numerous trips by barges and other vessels providing materials.

As development moves farther offshore, we anticipate much greater aircraft and vessel support. Bowheads may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mi). Marine-vessel traffic also may include seagoing barges transporting equipment and supplies from Southcentral Alaska to drilling locations, most likely between mid-August and mid- to late September. If the barge traffic continues into September, some bowheads may be disturbed. Fleeing behavior from vessel traffic generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Given results from Northstar regarding noise from barges, and the bowheads reaction to moving vessels, the level of barge and vessel activity that would occur if development and production proceeds as envisioned in the scenario, could potentially cause bowhead whales to avoid the area between the production platform and docking facilities during the period of activity. The significance of such a potential effect would depend on where the production facility was located.

Overall, bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects. Bowhead whale response to certain noise sources varies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age.

As time goes on, many of these activities can and probably will occur in both program areas in the same season and, in some cases, in closely adjacent areas. In 2006, 2D and 3D seismic surveys, icebreaker activity for transit, high-resolution surveys, and other support-vessel traffic were expected in the Beaufort Sea. Aerial surveys also were conducted. In 2007, exploration drilling, 2D and 3D seismic surveying, and high-resolution seismic surveys occurred in the Beaufort Sea and the Chukchi Sea. Similar activity is expected in 2008 and future years. If these activities are clumped in space and coincident in time and place with large numbers of bowhead whales, large numbers of bowheads could be adversely affected.

Data are sufficient to conclude that all response to future noise and disturbance is likely to vary with time of year; sex and reproductive status of individuals exposed; site (because of differences in noise propagation and use by bowheads); activity and the exact characteristics of that activity (e.g., drilling versus seismic, airgun array and configuration, etc.); the animal's motivation to be in an area; and options for alternative routes, places to feed, rest, nurse, etc. While habituation is seen in some species, and behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic operations, localized avoidance still occurred. We believe that it is much less likely that bowheads will habituate to at least certain types of noise than some other species because they are hunted annually and, thus, many individuals may have a strong negative association with human noise.

The potential total adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in an extremely long-lived species such as the bowhead whale are unknown. Available information does not indicate any long-term adverse effects on the BCB Seas bowhead from the high level of seismic surveys and exploration drilling during the 1980s in the Beaufort and Chukchi seas. However, sublethal impacts on health (such as reduced hearing or increased stress) could not be detected and were not specifically tested for in this population. The rate of this population's increase in abundance does not indicate any sublethal effects (if they occurred) resulted in an effect on this population's recovery. There has been no documented evidence that noise from previous OCS operations has served as a barrier to migration.

Because bowheads respond behaviorally to loud noise, they are less likely to suffer hearing loss from increased noise. However, bowheads are more tolerant of noise when feeding; and future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise on bowheads, including the potential for increased noise to cause physiological stress responses.

We acknowledge that we are not certain about the nature of long-term effects if multiple exploration seismic surveys and other noise and disturbance sources occurred for many years within an area that was frequently used by feeding or resting by large numbers of bowhead whales. Concentrations of loud noise and disturbance activities during the open-water period have the potential to cause large numbers of bowheads to avoid using areas for resting and feeding for long periods of time (days to months) while the noise producing activities continue. We believe that the strongest effects could be avoided through careful shaping of the action through the implementation of sufficient monitoring coupled with adaptive management to focus area, timing and bowhead presence-related mitigating measures where most needed.

Fin and Humpback Whales. Our summary of information about the current and historic distributions of fin whales and humpback whales in the Arctic indicate that:

- fin whales, a few individuals, are likely to be exposed to and effected by potential noise and disturbance associated with OCS oil and gas activities that could occur within the Chukchi Sea or the Beaufort Sea Planning Area; but they could be disturbed by an increase in oil- and gas-related vessel traffic and shipping through the Bering Strait that could result from increased activities in the two arctic planning areas relative to existing lease activity. Such effects should be temporary and minor.
- humpback whales are likely to be exposed to and effected by potential noise and disturbance associated with many of the actions that could occur within the Chukchi Sea and/or the Beaufort Sea Planning Areas. They could be disturbed by an increase in oil and gas-related shipping through the Bering Strait that could result from increased activities in the two arctic planning areas. Such effects should be temporary and minor.

Vessel-based marine mammal-observer sightings made in the open-water seasons of 2006 and 2007 confirmed humpback use of the western Beaufort Sea and the Chukchi Sea Planning Areas, and adjacent areas in the southeast Chukchi Sea. Information indicates but does not confirm these whales are from the Western North Pacific Stock (WNPS). However, there are no sufficient current data available for these areas on which to determine current humpback whale use, abundance, distribution, habitat selection, key use areas, or verified stock of origin.

Bowhead, fin, and humpback whales are known to inhabit the southwestern portions of the Chukchi Sea in waters adjacent to the coast of the Chukchi Peninsula. They also inhabit the Bering Strait and northerly portions of the Bering Sea. They could be disturbed by noise resulting from increased OCS oil- and gas-related shipping and transit through the Bering Strait attributed to activities in the two arctic planning areas. Such effects should be temporary and minor.

Based on available information, we conclude it is unlikely that there would be adverse effects on fin whales from noise-causing activities in the Beaufort Sea or Chukchi Sea Planning Areas.

In summary, there likely would be adverse effects to humpback whales from noise and disturbance from OCS-related oil and gas activities in the Beaufort Sea and Chukchi Sea Planning Areas. Overall, humpback whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects similar in nature to those indicated for bowhead whales. Humpback whale response to certain noise sources varies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age. Active monitoring would provide an opportunity to define stock of origin, spatial and temporal distribution patterns, habitat selection and use areas, and trends in abundance from which to make informed in-season and longer term decisions and mitigation to guide oil and gas activities. Such monitoring is valuable to provide timely mitigation actions, minimize adverse effects of noise related to OCS oil and gas activities, and improve knowledge of whales and their habitat use dynamics in concert with the planning areas' changing uses and ecology. The WNPS is the assumed stock of origin of the humpbacks in the planning areas. This stock is subject to cumulative mortality and effects from activities outside U.S. waters; its numbers are low (estimated 394) and it is vulnerable, and small impacts can have marked population-level effects. Information regarding humpback whales in the Arctic are limited and insufficient to define use areas, habitat selection and preferences, population productivity and abundance, movement patterns and if the presence in 2007 continue to be a recurring event or trend.

4.4.1.6.1.1.10. Potential Effects from Discharges. There could be alterations in bowhead and humpback habitat as a result of exploration, including localized pollution and habitat destruction. We refer readers to the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a) for a detailed discussion of

drilling muds and other discharges associated with exploration drilling, with probable scenarios regarding the disposal of these substances and for discussion of the potential effects on water quality from their discharge. Any potential adverse effects on endangered whales from discharges are directly related to whether or not any potentially harmful substances are released to the marine environment, what their fate in that environment likely is (e.g., different fates could include rapid dilution or biomagnification through the food chain) and, thus, whether they are bioavailable to the species of interest.

Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the EPA's NPDES permit. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution/deposition of these materials. Exploration drilling muds and cuttings may cover portions of the seafloor and cause localized pollution. However, the effects likely would be negligible, because bowheads feed primarily on pelagic zooplankton and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat.

Bottom-founded drilling units and/or gravel islands may cover areas of benthic habitat that support epibenthic invertebrates used for food by bowhead whales. Muds and cuttings from development drilling from platforms are expected to be treated and disposed of in disposal wells. Muds and cuttings from satellite development wells are expected to be barged either to the host platform for downhole disposal or to shore for disposal. Produced waters are expected to be reinjected.

Gravel island-construction activities, including placement of fill material, or installation of sheetpile or gravel bags for slope protection could cause loss of habitat, depending on the location of the gravel island. This construction would cause temporary sediment suspension or turbidity in the water as well as noise and disturbance (see noise and disturbance section).

4.4.1.6.1.1.1.11. Potential Effects of Large and Small Petroleum Spills. Exposure of endangered whales to petroleum could result from small and large spills due to a number of ongoing and future activities. These include vessel accidents and sinking; aircraft accidents and emergency jettison of fuel; equipment malfunction during fuel transfers; during oil and gas exploration, development and production activities; pipeline and infrastructure failure. Following a large oil spill, bowhead or other baleen whales could suffer adverse effects due to:

- inhalation of toxic components of crude oil;
- ingesting oil and/or contaminated prey;
- fouling of their baleen;
- oiling of skin, eyes, and conjunctive membranes causing ;
- reduced food source; and
- displacement from feeding areas.
-

Because of their extreme longevity, these whales are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their ranges and long-distance transport of other pollutants, individual whales may experience multiple large and small polluting events within their lifetime.

4.4.1.6.1.1.1.11.1. Large Oil Spills. Although there is no conclusive evidence that large baleen whales would be killed as a result of contact with spilled oil, the mammalian literature indicates that adult whales could die from prolonged exposure to oil. It is well documented that exposure of at least some mammals to petroleum hydrocarbons through surface contact, ingestion, and especially inhalation can be harmful. Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions,

can cause temporary or permanent damage of the mucous membranes and eyes (Davis, Schafer, and Bell, 1960) or epidermis (Hansbrough et al., 1985; St. Aubin, 1988; Walsh et al., 1974). Contact with crude oil can damage eyes (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill-treatment centers (Wilson et al., 1990) after the EVOS. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anaesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988). Physiological function impairment potentially resulting from inhalation of volatile aromatic compounds appears to be reversible in humans when removed from a polluted air environment; however whether or not this is the case for bowhead, humpback or fin whales is unknown

Many polycyclic aromatic hydrocarbons (PAHs) are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact the birth weight of young. After seals were experimentally dosed with crude oil, increased gastrointestinal motility and vocalization and decreased sleep were observed (Geraci and Smith, 1976; Engelhardt, 1985, 1987). Oil ingestion can decrease food assimilation of prey eaten (St. Aubin, 1988). Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

There are few postspill studies with sufficient details to reach firm conclusions about the effects, especially the long-term effects, of an oil spill on free-ranging populations of marine mammals. However, available evidence suggests that mammalian species vary in their vulnerability to short-term damage from surface contact with oil and ingestion. While differences in acute vulnerability to oil contamination do exist due to ecological (e.g., nearshore versus offshore habitat) and physiological reasons (e.g., dependence on fur rather than blubber for thermal protection), species also vary greatly in the amount of information that has been collected about them and about their potential oil vulnerability. These facts are linked, because the most vulnerable species have received the most focused studies. However, it also is the case that it is more difficult to obtain detailed information on the health, development, reproduction, and survival of large cetaceans than on some other marine mammals. Data are not available that would permit evaluation of the potential for long-term sublethal effects on large cetaceans. Marine mammals also can be affected indirectly after a spill due to oil and cleanup disturbance and damage to prey resources. Both short- and long-term effects potentially can occur from increased boat and aircraft traffic associated with spills. Longer term oil contamination of food sources including lactating mother's milk, changes in distribution of prey species, decreased productivity/abundance of prey species, and localized mortality of prey species of various high trophic-level marine mammals can further concentrate contaminants.

Potential Effects from Inhalation of Toxic Components of Crude Oil and Natural Gas. The greatest threat to large cetaceans probably is from inhalation of volatile compounds present in fresh crude oil. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of bowheads or other cetaceans could occur if they surfaced in large quantities of fresh oil. Bowhead and humpback calves would be especially vulnerable to fumes from a large spill, because they take more breaths than do their mothers and spend more time at the surface. Thus, it is likely they would be more likely to succumb to inhalation of toxic aromatic compounds. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin,

1982), have anesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988).

The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, reduced immune function, reduced reproduction or longer dependency periods) effects on large cetaceans from a large oil spill is essentially unknown. There are no data on large cetaceans adequate to evaluate the probability of sublethal effects.

Geraci and St. Aubin (1982) calculated the concentrations of hydrocarbons associated with a theoretical spill of a typical light crude oil. They calculated the concentrations of the more volatile fractions of crude oil in air. The results showed that vapor concentrations could reach critical levels for the first few hours after a spill. If a whale or dolphin were unable to leave the immediate area of a spill during that time, it would inhale some vapors, perhaps enough to cause damage. Fraker (1984) stated that a whale surfacing in an oil spill will inhale vapors of the lighter petroleum fractions, and many of these can be harmful in high concentrations. Natural gas and condensates would disperse rapidly; however, prolonged exposure and inhalation would have similar pathways to adverse effects as the lighter components of oil and would not persist in the water column or surface. Animals that are away from the immediate area or that are exposed to weathered oils would not be expected to suffer serious consequences from inhalation, regardless of their condition. The most serious situation would occur if oil spilled into a lead that bowheads could not escape. In this case, Bratton et al. (1993) theorized the whales could inhale oil vapor that would irritate their mucous membranes or respiratory tract. They also could absorb volatile hydrocarbons into the bloodstream. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them. The number of whales affected would depend on how large the spill was, its behavior after being spilled, and how many whales were present in areas contacted in the first several days following the spill.

Potential Effects from Ingestion of Spilled Oil. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death, as many polycyclic aromatic hydrocarbons are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact birth weight and health of young in at least some mammals (Khan et al., 1987; Currie et al., 1970). In at least some marine mammals, digestion and behavior is affected with decrease food assimilation of prey eaten (St. Aubin, 1988), increased gastrointestinal motility, increased vocalization, and decreased sleep (Geraci and Smith, 1976; Engelhardt, 1985, 1987).

Bowheads sometimes skim the water surface while feeding, filtering a lot of water for extended periods. Albert (1981) suggested that whales could take in tarballs or large “blobs” of oil with prey. He also said that swallowed baleen “hairs” mix with the oil and mat together into small balls. These balls could block the stomach at the connecting channel, which is a very narrow tube connecting the stomach's fundic and pyloric chambers (the second and fourth chambers of the stomach) (Tarpley et al., 1987). Hansen (1985; 1992) suggests that cetaceans can metabolize ingested oil, because they have cytochrome p-450 in their livers (Hansen, 1992). The presence of cytochrome p-450 (a protein involved in the enzyme system associated with the metabolism and detoxification of a wide variety of foreign compounds, including components of crude oil) suggests that cetaceans should be able to detoxify oil (Geraci and St. Aubin, 1982, as cited in Hansen, 1992). Hansen also suggests that digestion may break down any oil that adheres to baleen filaments and causes clumping (Hansen, 1985). Observations and stranding records do not reveal whether cetaceans would feed around a fresh oil spill long enough to accumulate a critical dose of oil. There is great uncertainty about the potential effects of ingestion of spilled oil on bowheads, especially on bowhead calves. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

Bowheads may swallow some oil-contaminated prey, but it likely would be only a small part of their food. It is not known if bowheads would leave a feeding area where prey was abundant following a spill. Some zooplankton eaten by bowheads consume oil particles, and bioaccumulation can result (see section on Potential Effects on Food Source below). Tissue studies by Geraci and St. Aubin (1990) revealed low levels of naphthalene in the livers and blubber of baleen whales. This result suggests that prey have low concentrations in their tissues, or that baleen whales may be able to metabolize and excrete certain petroleum hydrocarbons.

Potential Effects from Baleen Fouling. If a bowhead encountered spilled oil, baleen hairs might be fouled, which would reduce a whale's filtration efficiency during feeding. Lambertsen et al. (2005) concluded that the current state of knowledge of how oil would affect the function of the mouth of right whales and bowheads can be considered poor, despite considerable past research on the effects of oil on cetaceans. Lambertsen et al. (2005) believe that the resistance of the baleen is significantly increased by oil fouling, and that the most likely adverse effect would be a substantial reduction in capture of larger, more actively mobile species, that is euphausiids, with possible reductions in capture of copepods and other prey. They also concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

Earlier studies on baleen fouling were summarized by Geraci (1990) who, with colleagues, had also undertaken studies of the effects of oil on baleen function. Geraci (1990) noted that while there was a great deal of interest in the possibility that residues of oil may adhere to baleen plates so as to block the flow of water and interfere with feeding, the concerns are largely speculative. He also noted that effects may be imperceptible, although leading to subtle, long-term consequences to the affected animal, and concluded that a safe assumption is that any substance in seawater that alters the characteristics of the plates, the integrity of the hairs, or the porosity of the sieve may jeopardize the nutritional well-being of the animal. Braithwaite (1983, as cited in Bratton et al., 1993) used a simple system to show a 5-10% decrease in filtration efficiency of bowhead baleen after fouling, which lasted for up to 30 days.

Geraci (1990) summarized studies by Geraci and St. Aubin (1982, 1985) where the effects of contamination by different kinds of oil on humpback, sei, fin, and gray whale baleen were tested in saltwater ranging from 0-20 °C. In these studies, resistance to flow of some humpback baleen was increased more than 100%, less than 75% in gray and sei whale baleen, and gray whale samples were "relatively unaffected" (Geraci, 1990:186). Resistance to water flow through baleen was increased the greatest with contamination by Bunker C oil at the coldest temperatures. He summarized that oil of medium weight had little effect on resistance to water flow at any temperature. Fraker (1984) noted that there was a reduction in filtering efficiency in all cases, but only when the baleen was fouled with 10 millimeters of oil was the change statistically different.

In the study in which baleen from fin, sei, humpback, and gray whales was oiled, Geraci and St. Aubin (1985) found that 70% of the oil adhering to baleen plates was lost within 30 minutes (Geraci, 1990) and in 8 of 11 trials, more than 95% of the oil was cleared after 24 hours. The study could not detect any change in resistance to water flowing through baleen after 24 hours. The baleen from these whales is shorter and coarser than that of bowhead whales, whose longer baleen has many hairlike filaments. Geraci (1990:187) concluded that:

Combined evidence...suggests that a spill of heavy oil, or residual patches of weathered oil, could interfere with the feeding efficiency of the fouled plates for several days at least. Effects would likely be cumulative in an animal feeding in a region so blanketed by weathered oil that the rate of cleansing is outpaced by fouling. That condition could describe the heart of a spill, or a contaminated bay or lead.

Lighter oil should result in less interference with feeding efficiency. Lambertsen et al. (2005:350) concluded that results of their studies indicate that Geraci's analysis of physiologic effects of oiling on mysticete baleen "considered baleen function to be powered solely by hydraulic pressure," a perspective they characterized as a "gross oversimplification of the relevant physiology."

A reduction in food caught in the baleen could have an adverse affect on the body condition and health of affected whales. If such an effect lasted for 30 days, as suggested by the experiments of Braithwaite (1983), this potentially could be an effect that lasted a substantial proportion of the period that bowheads spend on the summer feeding grounds. Repeated baleen fouling over a long time, however, also might reduce food intake and blubber deposition, which could harm the bowheads. As pointed out by Geraci (1990), the greatest potential for adverse effects to bowheads would be if a spill occurred in the spring lead system.

Potential Effects of Direct Contact of Skin, Eyes, Conjunctive Membranes and other Surfaces with Spilled Oil. The effects of oil contacting skin are largely speculative, as there is no information about how long spilled oil will adhere to the skin of a free-ranging whale. It might be possible that oil will wash off the skin and body surface shortly after bowheads vacate oiled areas; however, oil might adhere to the skin and other surface features (such as sensory hairs) longer if bowheads remained in or left the oiled area.

Bowhead whale and other marine mammal eyes may be vulnerable to damage from crude oil on the water due to their eye's unusual anatomical structure (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill-treatment centers (Wilson et al., 1990) after the EVOS.

In a study on nonbaleen whales and other cetaceans, Harvey and Dahlheim (1994) observed 80 Dall's porpoises, 18 killer whales, and 2 harbor porpoises in oil on the water's surface from the EVOS, and they confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. One Dall's porpoise, which had oil on the dorsal half of its body, appeared stressed because of its labored breathing pattern. None of the observed cetaceans appeared to alter their behaviors when in oiled areas, and the authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present.

Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect and they concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. Geraci and St. Aubin also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin and concluded that dead tissue protects underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in natural conditions, contact with oil would be less harmful to cetaceans than they and others had proposed.

It is not clear how long crude oil would remain on a free-ranging cetacean's skin once it was oiled. Bratton et al. (1993) synthesized studies on the potential effects of contaminants on bowhead whales, and they concluded that no published data proved oil fouling of the skin of any free-living whales and that bowhead whales contacting fresh or weathered petroleum are unlikely to suffer harm. Albert (1981) suggested that oil would adhere to the skin's rough surfaces (eroded areas on the skin's surface, tactile

hairs, and depressions around the tactile hairs), and that eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged.

The potential effect of crude oil on the function of the cetacean blowhole is unknown. As noted, a Dall's porpoise was observed after the EVOS with crude oil covering its skin and blowhole. This individual was described as having labored breathing. Other porpoise swimming in the same area in oil did not appear to be oiled or to have abnormal behavior (Harvey and Dahlheim, 1994).

Potential Effects from Oil Contacting Food Sources. A large oil spill probably would not permanently affect zooplankton populations, the bowhead's major food source, and major effects are most likely to occur nearshore (Richardson et al., 1987, as cited in Bratton et al., 1993). The amount of zooplankton lost, even in a large oil spill, would be very small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993).

The potential effects to bowheads of exposure to aqueous polyaromatic compounds (PACs) through their food are unknown. Because of their extreme longevity, bowheads are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events within their lifetime.

Duesterloh, Short, and Barron (2002) indicated that aqueous PAC dissolved from weathered Alaska North Slope crude oil are phototoxic to subarctic marine copepods at PAC concentrations that would likely result from an oil spill and at ultraviolet (UV) levels that are encountered in nature. *Calanus marshallae* exposed to UV in natural sunlight and low doses [~2 micrograms (μg) of total powdered activated carbon per liter (PAC/L)] of the water soluble fraction of weathered North Slope crude oil for 24 hours) showed an 80-100% morbidity and mortality as compared to <10% with exposure to the oil-only or sun-light only treatments. One-hundred percent mortality occurred in *Metridia okhotensis* with the oil and UV treatment, while only 5% mortality occurred with the oil treatment alone. Duesterloh, Short, and Barron (2002) reported that phototoxic concentrations to some copepod species were lower by a factor of 23 to >4,000 than the lethal concentrations of total PAC alone (0.05-9.4 milligram per liter [mg/L]).

This research also indicated that copepods may passively accumulate PACs from water and, thereby, could serve as a conduit for the transfer of PAC to higher trophic level consumers. Bioaccumulation factors were ~2,000 for *M. okhotensis* and ~8,000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher bioaccumulation than many other species of copepods because of their characteristically high lipid content. The authors concluded that phototoxic effects on copepods could conceivably cause ecosystem disruptions that have not been accounted for in traditional oil spill damage assessments. Particularly in nearshore habitats where vertical migration of copepods is inhibited due to shallow depths and geographical enclosure, phototoxicity could cause mass mortality in the local plankton population (Duesterloh, Short, and Barron, 2002).

Potential Effects from Displacement from Feeding Areas. There is a paucity of information about whether bowhead whales may be temporarily displaced from areas affected by an oil spill or cleanup operations. However, Thomas Brower, Sr. (1980) described the effects on bowhead whales from a 25,000-gallon (595-bbl) oil spill at Elson Lagoon (Plover Islands) in 1944. It took approximately 4 years for the oil to disappear and for 4 years after the oil spill, Brower observed that bowhead whales made a wide detour out to sea when passing near Elson Lagoon/Plover Islands during fall migration. Bowhead whales normally would move closer to these islands during the fall migration. These observations indicate that some displacement of whales may occur in the event of a large oil spill, and that the displacement may last for several years. Based on these observations, it also appears that

bowhead whales may have some ability to detect an oil spill and avoid surfacing in the oil by detouring around the area of the spill.

Several other investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. For example, during the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and a large number of white-sided dolphins were also observed swimming, playing, and feeding in and near the slicks, and no difference in behavior was observed between cetaceans within the slick and those beyond it. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities.

After the EVOS, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented no effects on the humpback whale. von Ziegesar, Miller, and Dahlheim (1994) found no indication of a change in abundance, calving rates, seasonal residency time of female-calf pairs, or mortality in humpback whales as a result of that spill, although they did see temporary displacement from some areas of Prince William Sound.

Cleanup operations following a large oil spill would be expected to involve multiple marine vessels operating in the spill area for extended periods of time, perhaps over multiple years. Based on information provided in the discussion of impacts associated with vessel traffic, bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi).

After a large spill, there typically are helicopter and fixed-wing aircraft overflights to track the spill and to determine distributions of wildlife that may be at risk from the spill. Most bowheads are unlikely to react significantly to occasional single passes by helicopters flying at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993; Patenaude et al., 1997) and may have shortened surface time (Patenaude et al., 1997). Bowhead reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995a). Whales should resume their normal activities within minutes. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Based on all of the above information, there potentially could be displacement of bowhead whales from a feeding area following a large spill, and this displacement could last as long as there is a large amount of oil and related cleanup vessels present.

Potential for the Exposure of the Three Species of Endangered Whales to Large Oil Spills.

Bowhead whales are the most likely of ESA-listed baleen whales to be impacted if an oil spill occurred in either the Chukchi Sea or Beaufort Sea Planning Areas, because they commonly occur seasonally in areas where such spills could occur. Bowhead whales use of portions of the both the Chukchi Sea and Beaufort Sea evaluation areas for: spring and fall migration; feeding; calving; resting; and limited breeding. Most of the calving for this population probably occurs between the Bering Strait and Point Barrow. Thus, they could be exposed to freshly spilled oil as well as to oil that is spilled at some distance and that moves into

areas inhabited by whales. It is important to know whether or not a species has the potential for exposure to oil that is spilled on the site, because freshly spilled oil contains high levels of toxic aromatic compounds that, if inhaled, can cause serious health effects or death. Oil that moves some distance from a site may or may not (e.g., depending on temperature and whether the oil becomes frozen into ice) retain high levels of toxic aromatic compounds.

Humpback whales are likely to be affected, as discussed in Section 4.4.1.6.1.1.12, from an oil spill in the Chukchi Sea Planning Area and the far western portion of the Beaufort Sea Planning Area. Information is insufficient to verify the duration of humpback occurrence in the area, abundance or use areas, but they have been observed where petroleum spills or trajectory contact could occur. Current information suggests that humpbacks in the Arctic are associated with open-water periods in summer and the fall feeding period and are not associated with the confines of spring ice and the lead system, and they exit the Chukchi Sea prior to ice buildup in fall. Calving does not occur in the Arctic, although nursing of calves is likely to be present. Depending on oil-spill trajectories, humpback whales west and south of the Chukchi Sea Planning Area potentially could be exposed to aged oil with low levels of toxic aromatic compounds spilled in the Chukchi Sea planning area that contacted marine waters adjacent to the Russian Chukchi Peninsula Coast or that contacted the Bering Strait.

As previously summarized, fin whales are not expected to typically appear at any time of the year within either the Chukchi Sea or the Beaufort Sea Planning Areas. All three endangered species of whales noted above have been documented to feed in coastal waters of the southwestern Chukchi Sea, adjacent to the Russian Chukchi Peninsula in the summer and autumn. Depending on oil-spill trajectories, they potentially could be exposed to aged oil with low levels of toxic aromatic compounds spilled in the Chukchi Sea planning area that contacted marine waters adjacent to the Chukchi Peninsula's Chukchi Sea coast or that contacted the Bering Strait. These whales could be affected as per the discussion in Section 4.4.1.6.1.1.12, with the exception of inhalation effects.

4.4.1.6.1.1.11.2. Small, Chronic Oil Spills. Fuel spills associated with the vessels used for various oil and gas activities could occur, especially during fuel transfer. There could be localized, short-term alterations in bowhead, fin, and humpback habitat and habitat use as a result of such a spill. Whale exposure to noise from petroleum-spill cleanup is further decreased, as whales generally avoid noise related to vessel activities. Whales likely would not remain in the immediate area of a spill and would avoid the vessel activity, human activity, and noise associated with cleanup of such a spill. Whales exposed to a small fuel spill likely would experience temporary, nonlethal effects. Data available from other mammals indicate that prolonged exposure, or particularly exposure of nursing young to spilled oil, potentially could result in temporary or potentially permanent sublethal effects. For example, ingestion of oil reduces food assimilation, thereby reducing the nutritional value of food. However, it is unlikely such an impact would be detectable. Small, chronic petroleum (fuel and oil) spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Fueling-operation spills during open-water periods could occur; however, spill-response capability is readily available for cleanup response from personnel and equipment aboard the involved vessels. These conclusions are supported by the best available information.

The potential effects to endangered whales from exposure to polyaromatic compounds (PACs) through their food are unknown. Copepods may passively accumulate PACs from water and could serve as a conduit for the transfer of PACs to higher trophic-level consumers. A small fuel spill would be localized and would not permanently affect zooplankton populations and higher trophic-level consumers that are bowhead or humpback prey. The amount of zooplankton and other prey lost in such a spill likely would be undetectable compared to what is available on the whales' summer feeding grounds.

It is difficult to accurately predict the effects of oil on bowhead, humpback and fin whales (or any cetacean) because of a lack of data on the metabolism of these species and because of inconclusive results of examinations of baleen whales found dead after major oil releases.

We conclude that individual bowhead, fin or humpback whales potentially could be exposed to small fuel oil spills, and this exposure could have short-term, nonlethal effects on health. We expect seismic-survey-related small-spill effects to be negligible.

Areas and Circumstances Where Potential Effects of Petroleum Spills(s) are Likely to be Greater than Typical. The number of bowhead or other whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. Bowhead whales may be vulnerable particularly to oil-spill effects due to their use of ice edges and leads where spilled oil may accumulate (Engelhardt, 1987:104). Primarily because of the uniqueness of the bowhead and its apparently obligate use of spring leads and polynyas as its migratory path between wintering and summering grounds, we are uncertain of the potential severity of impact should a large or very large oil spill occur within such a system, especially if spring migration were under way and hundreds of females were calving in or near those leads.

There are two situations in which bowheads are at particular risk in the event of a large oil spill. The first situation would be if a large or very large spill occurred while the whales were migrating north through the Chukchi Sea or east through the Beaufort Sea, traveling through the spring leads and polynyas, particularly during the period when large numbers of females are calving or accompanied by very young calves. Calves would be more vulnerable than adults, because they would be more restricted to open water within the lead system, have less physical ability to avoid the open water within the lead system by traveling under the ice, or breaking moderate-thickness ice to breathe. The effects of an oil spill on cetacean newborns or other calves are not known. The potential effects of contact or detection of spilled oil by near term, or postpartum females are not known. The spring migration path through the Chukchi Sea is relatively constrained. The area appears to be the primary calving ground of the BCB stock, and it must be assumed that the majority of the entire stock makes this migration to get to summering grounds. The spring migration across the Alaska Beaufort Sea, while still dependent on the open leads, occurs progressively farther offshore. It is less likely to be in the vicinity of fresh spills because they would be farther from oil and gas infrastructure and sources of spills. The potential exists for a substantial mortality and sublethal effects to a year's cohort of calves if a large spill of fresh oil (evaporating high concentrations of volatile toxic components into the atmosphere immediately above the water) occurred during spring migration, or spilled oil concentrated in the polynya system when whales, including calves, were passing through in large numbers and experiencing prolonged contact and exposure to inhalation of volatile components of spilled oil.

The potential for there to be adverse effects from a large oil spill also likely would be greater (than in more typical circumstances) if a very large spill of fresh oil contacted one or more large aggregation of bowheads, especially (but not exclusively) if such an aggregation contained large numbers of females and calves. Such aggregations occasionally have been documented in MMS aerial bowhead whale surveys. For example, Treacy (1998) observed large feeding aggregations, including relatively large numbers of calves (e.g., groups of 77[6], 62[5], 57[7], and 51[0] where the numbers given in brackets are the numbers of calves) of feeding bowheads in waters off of Dease Inlet/Smith Bay in 1997 and in 1998. However, in some years no large aggregations of bowheads were seen anywhere within the survey area. When seen, the aggregations were in open water. The likelihood of a very large spill occurring and contacting such a group is low but not outside the range of possibilities. The factors associated with the presence of such groups are not yet clear. It is not known if they would leave the area heavily contaminated with crude oil.

Bowhead whales indicate they would avoid a spill area where intensive spill response activities would occur including substantial vessel traffic and noise.

4.4.1.6.1.1.1.12. Potential Effects from Subsistence Hunting. Indigenous peoples of the Arctic and subarctic of what is now the Chukchi Peninsula have hunted bowhead whales, and some villages have taken humpback whales for at least 2,000 years (Bogoslovskaya, Votrogov, and Krupnik, 1982, Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. No reported harvest of humpback or fin whales has been reported by subsistence hunters in Alaska and Russia from the WNPS in recent decades. There is no indication that prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level to these species. However, modern technology has changed the potential for any lethal hunting of whales to cause population-level adverse effects if unregulated. Under the authority of the International Whaling Commission (IWC), the subsistence take from the Western Arctic population of bowhead whales has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the Alaska Eskimo Whaling Commission (AEWC) through a cooperative agreement between the AEWC and the United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) (NMFS, 2003b). There is no recent or current regulated subsistence harvest on the humpback or fin whale populations in the Arctic.

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, monitored, managed, and regulated, helps to determine the resilience of the population to other effects that potentially could cause lethal takes.

From 1974-2007, a total of 995 whales were landed by 11 villages (Suydam and George (2004). Eleven Bering, Chukchi, and Beaufort seas, Alaska, villages harvested an additional 36 whales landed in 2004 (Suydam et al., 2004), and 68 struck (55 landed) in 2005 (Suydam et al., 2005); 39 struck (31 landed in 2006) (IWC, 2007); 63 struck (41 landed) in 2007 (Suydam et al., 2008a). Hunters in Aklavik in western arctic Canada killed one bowhead in 1991 and another in 1996 (Angliss and Outlaw, 2007). Russian subsistence hunters harvested one bowhead whale in 1999, one in 2000, three in 2003 (Borodin, 2004), one in 2004 (Borodin, 2005), two in 2005, and none in 2006 and 2007. The average harvest by Alaska, Canada, and Russia from 2001-2005 is 46.0 bowhead whales (Angliss and Outlaw, 2007).

Alaskan Native hunters from 10 villages harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. The status of the population is closely monitored, and these activities are closely regulated.

During the IWC meeting held in Anchorage, Alaska May 28-31, 2008, the IWC renewed the catch limits for the BCB Seas bowhead population established at a special meeting in 2002 by consensus, allowing for a combined total of up to 255 bowhead whales to be landed in the years 2007-2012 (IWC, 2002). The number of bowhead whales that can be struck in any given year shall not exceed 67 except that any unused portion of a strike quota from any year, including from the 1998-2002 quota block, shall be carried forward and added to the strike quota of any subsequent year, provided no more than 15 strikes shall be added to the quota for any one year. The IWC further specified that “It is forbidden to strike, take or kill calves or any bowhead whale accompanied by a calf” (IWC, 2002). The NMFS (2003b:4)

points out that the “Quota of 56 landed whales per year continues to be shared between Alaskan and Russian Natives, the quota does not meet the documented need for landed whales by Alaska Natives.”

In 2004, NMFS (69 FR 7910) announced the aboriginal subsistence whaling quota for bowhead whales and other limitations deriving from regulations adopted at the 2002 Special Meeting of the IWC (as outlined above). At the end of the 2007 harvest, there were 15 unused strikes available for carry-forward, so the combined strike quota for 2008 was 82 (67 + 15) (73 FR 22287). This arrangement ensured that the total quota of bowhead whales landed and struck in 2007 did not exceed the quotas set by the IWC. Under an arrangement between the United States and the Russian Federation, the Russian Natives may use no more than seven strikes, and the Alaskan Eskimos may use no more than 75 strikes. The NMFS assigned 75 strikes to the Alaska Eskimos, and the AEWC allocated these strikes among the 10 villages whose cultural and subsistence needs have been documented in past requests for bowhead quotas from the IWC. The AEWC ensures that its hunters use no more than 75 strikes. This process occurs every year.

Both males and females are hunted but, under the IWC rules, there is a prohibition on the take of females accompanied by calves. Calves occasionally are mistakenly taken and lactating females also are harvested, apparently due to difficulties in identifying some female/calf pairs during hunting. Additional details regarding sex, age, and reproductive status of these harvested whales are provided in annual reports from the AEWC and the NSB (e.g., Suydam et al., 2005) to the IWC. A few whales also are harvested by subsistence hunters in Russia.

Bowheads are hunted at Gambell and Savoonga on St. Lawrence Island and along the Chukotkan coast. On the northward spring migration, harvests may occur by the villages of Wales, Little Diomedea, Kivalina, Point Hope, Wainwright, and Barrow. During their westward migration in autumn, whales are harvested by Kaktovik, Nuiqsut, and Barrow. At St. Lawrence Island, fall migrants can be hunted as late as December (IWC, 2004b).

The sustained growth of the BCB Seas bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003a; NMFS, 2003b), it is unlikely this source of mortality would contribute to a significant adverse effect on the recovery and long-term viability of this population.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during their northward spring migration in the Bering Sea; in the Chukchi Sea in the spring lead system; and in the Beaufort Sea spring lead system near Barrow; during their fall westward migration in subsistence-hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; during hunting along the Chukotka coast; and hunting in wintering areas near St. Lawrence Island. Lowry, Sheffield, and George (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding. When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck, and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive used in the hunt, the boat motors, and any sounds made by the injured whale. The NMFS (2003a) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: “...the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians, listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike ...” (NMFS, 2003a:35). We are not aware of data indicating how far hunting-related sounds

(e.g., the sounds of vessels and/or bombs) can propagate in areas where hunting typically occurs, but this is likely to vary with environmental conditions. It is not known if whales issue an “alarm call” or a “distress call” after being struck prior to reducing call rates.

The NMFS (2003a) reported that:

...whales may act skittish” and wary after a bomb detonates, or may be displaced further offshore (E. Brower, pers. com.). However, disturbances to migration as a result of a strike are temporary (J. George, 1996), as evidenced when several whales may be landed at Barrow in a single day. There is some potential that migrating whales, particularly calves, could be forced into thicker offshore ice as they avoid these noise sources. The experience of Native hunters suggests that the whales would be more likely to temporarily halt their migrations, turn 180 degrees away...(i.e., move back through the lead systems), or become highly sensitized as they continue moving (E. Brower, pers. comm.).

Bockstoce and Burns (1993) reported that during commercial whaling, which we emphasize differed greatly from the current subsistence take in terms of its magnitude and intensity, whalers found that:

...the whales, in the opinion of the whalers, began to adapt to the threat. In particular they vanished for several years in an area where a large number of kills had been made. Furthermore, the bowheads apparently quickly learned to distinguish the sound of a whaleboat approaching them, and when a whale was struck, all nearby bowheads would dive and flee. Such responses are similar to those reported by contemporary subsistence hunters.... Similarly, when a boat did approach close to bowheads, the animals were often noticed dodging or slumping in the water to avoid the harpoon.

Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where hunting was occurring on multiple, perhaps dozens or more, occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. However, we are not aware of information indicating long-term habitat avoidance has occurred with present levels of activity. Additionally, if, as reported above, whales become more “skittish” and more highly sensitized following a hunt, it may be that their subsequent reactions, over the short-term, to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

Available data are insufficient to determine whether there are longer term (longer than when hunting is occurring) changes in habitat use due to hunting. Because evidence indicates that bowhead whales are long lived, some bowhead whales may have been in the vicinity where subsistence hunting occurred on multiple, perhaps dozens or more, occasions. Thus, many whales may have cumulative exposure to subsistence-hunting activities.

Noise and disturbance from subsistence hunting serves as a seasonally and geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil-and gas-related activities, add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong, adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

Current mitigation of oil and gas activities is aimed primarily at avoiding harm to the whales from the activity, and to ensuring that the activity does not conflict with subsistence hunting of whales. The effect of this mitigation is that during the open-water season of relatively higher levels of oil- and gas-exploration activities, whales may be consecutively disturbed by oil and gas and subsistence activities during the entire open-water period.

We are not aware of information indicating long-term habitat avoidance has occurred with levels of activity that are currently occurring or that have occurred in the recent past. We emphasize that the subsistence take of bowhead whales appears to be sustainable, and all evidence indicates that the affected population is robust and continues to increase. We note that:

- Unlike most or all of the other potential impactors, the take of bowhead whales for subsistence has been occurring for at least 2,000 years.
- The take is of extremely high cultural significance to the whaling communities.
- The subsistence take is small compared to the estimated size of the population. The NMFS concluded that Alaskan Native hunters from 10 communities take <1% of the total population (NMFS, 2003a).
- The take is less than what would be consistent with the requirements of the IWC “Schedule,” a set of principles and guidelines that govern Scientific Committee recommendations on setting catch limits for commercial and aboriginal subsistence whaling. In 2002, the IWC’s Scientific Committee agreed “...that it is very likely a catch limit of 102 whales or less annually would be consistent with the requirements of the Schedule” (IWC, 2002:36).
- The AEWC and NMFS cooperate to conduct research on this population, to monitor the hunt, and to undertake other measures to ensure the long-term health and viability of this population.

The level of subsistence take of bowheads could increase over the life of the proposed actions as the human populations within bowhead hunting communities are increasing (IWC, 2002), and the current quota is well below what the IWC considers consistent with its guidelines (IWC, 2002, 2003b). The IWC considers population size and related nutritional needs in its quotas for aboriginal harvest.

In summary, it is not unlikely that up to 82 (67 + 15) whales may be struck (with the presumption that they could die, even if not retrieved) in a given year from 2008 through 2012, as long as a total of 280 is not exceeded over the 5-year block quota as set by the IWC at their 59th Annual Meeting (IWC, 2007). Please refer to the 2008 NOAA *Biological Opinion on the Issuance of Annual Quotas Authorizing the Harvest of Bowhead Whales to the Alaska Eskimo Whaling Commission for the Period 2008 through 2012* (NMFS, 2008a) and the final EIS (NMFS, 2006b). If the population of bowhead whales continues to increase in abundance, it is not unlikely that this quota could be increased for the next 5-year period (2013-2017). However, it also is likely that the quota will continue to be a small percentage of the estimated population size and would not have significant adverse impacts on the population. The subsistence take, while additive, actually is small as compared to the capacity of the population to absorb it and to thrive. We are aware of no other known potential human-related effects that approach, or could reasonably be predicted to approach, the level of this known removal. This activity also results in noise and disturbance that may have temporary effects on habitat use. We are not aware of information suggesting there have been any long-term modifications of habitat use due to this form of noise and disturbance. However, we also emphasize that the hunt is highly regulated, has limits on take, and places direct prohibition on the take of females with calves. Other potential effectors have less controllable and are mostly non-lethal effects, unless also purposely mitigated and shaped.

The existence of this hunt results in a relatively high level of Native, local, State, Federal, and international study, monitoring, and management of this population(s), which provides some safeguards for its long-term viability. Mitigations that are focused on protecting the hunt may have the unintended

effect of increasing overall impacts on the whales by focusing other (e.g., industrial) activities into periods and places that may act as temporary hunting refuges for the whales, unless MMS and NMFS also deliberately design mitigations to offset such an impacts.

4.4.1.6.1.1.13. Cumulative Effects from Global Forces. Changes in the Arctic physical environment appear to be most influenced by the warming trends experienced in recent decades. Trends imply the warming phenomena and resultant changes in oceanographic processes and temporal and spatial sea-ice distribution are likely to continue. Implications of arctic warming on bowhead, humpback, and fin whales cannot be predicted with any precision, but changes are indicated. This section briefly describes likely ongoing effects of changes in oceanographic processes and ice distribution on endangered whales in the Arctic.

Potential Effects of Changes in Oceanographic Processes and Sea-Ice Dynamics. The Arctic is experiencing a trend of an annual decrease of summer sea-ice extent, greater extent and longer periods of open water, earlier sea-ice melt in spring and later formation in early winter, thinner annual sea ice, decreasing multiyear ice, and greater ice retreat from coastlines. For the first time during 2006 and 2007, documented distribution of humpback whales moving into the central and eastern Chukchi Sea and western portion of the Beaufort Sea could be indications of habitat or prey changes occurring in those seas. Information is lacking regarding the nature of and magnitude of changes in baleen whale habitat characteristics, prey-base habitat productivity and distribution, interspecific competition, and other variables for the Chukchi and Beaufort seas. To understand ongoing changes in the Arctic, it may be helpful to compare to similar situations. Evidence indicates the Bering Sea is changing (Grebmeier et al., 2008). Springer et al. (1984) noted fluctuations in the physical environment from warming of the Bering Sea in the second half of the 1970s have led to changes in fish populations directly through physiological and behavioral effects, or indirectly by altering the abundance of important zooplankton prey populations. Increases or changes in productivity and distribution of zooplankton and the fish that prey on them could be providing greater opportunity for humpback whales to prey upon fish as well as zooplankton prey in the Arctic region. Such relationships in the Arctic remain speculative at this time. Increased competition related to changing distribution and productivity of zooplankton prey items between fish species, birds, newly documented humpback whales (information is insufficient to determine trends at this time), an increasing gray whale abundance and distribution, and bowhead whales in the Arctic region may also be a consideration that we cannot predict short- or long-term effects that could be likely. Changing patterns of distribution of large baleen whales and other oceanographic processes also could increase the presence and abundance of orcas that, at times, prey on baleen whales. Bowhead whales do not indicate detectable changes in current habitat use and migration patterns; however, humpback whale occurrence appears to be in a state of expansion. The suite of potential effects to bowhead whales from interspecific competition, changes in distribution and productivity of prey base and predation to date have not contributed to detectable changes in access to bowheads for subsistence hunters, a seasonal shift farther north as ice edge recedes farther north, engage in earlier spring migration and later fall migrations, productivity changes, or increased vulnerability to invasive pathogens and parasites.

Indirect effects from warming trends in the Arctic include potential effects from increased noise exposure and collision potential related to increases in vessel traffic and development activities in response to increased open-water area, emerging commercial opportunities and routes, and operational time period. Potential increased effects of commercial fisheries, including noise and disturbance, gear entanglement, prop strikes, and collisions could occur.

4.4.1.6.1.2. Mitigation Measures. The following measures are in effect to protect ESA-listed whale and other marine mammals during Federal seismic and exploratory drilling in the Beaufort Sea and Chukchi Sea. The Federal measures represent current Federal regulation, the collective result of recent

MMS Section 7 consultations for lease sales (Lease Sales 193, 186, 195 and 202), and programmatic seismic activities in the Beaufort and Chukchi seas. It is anticipated these mitigation measures would be implemented in future activities, as appropriate. Listed mitigation measures (excepting G&G standard permit stipulations) are predicated upon an applicant receiving MMPA authorization; however, MMS may apply additional measures in permits if MMPA authorization is not obtained by a permit applicant.

Federal Regulation. 50 CFR Part 224.103 b. Approaching humpback whales in Alaska (1) Prohibitions. ...it is unlawful for any person subject to jurisdiction of the United States to commit, to attempt to commit, to solicit another to commit, or to cause to be committed, within 200 nautical miles (370.4 km) of Alaska or within inland waters of the state any of the following acts...with respect to humpback whales:

- (i) Approach, by any means, including by interception (i.e., placing a vessel in the path of an oncoming humpback whale so that the whale surfaces within 100 yards of the vessel) within 100 yards of any humpback whale
- (ii) Cause a vessel or other object to approach within 100 yards of a humpback whale or
- (iii) Disrupt the normal behavior or prior activity of a whale by any other act or omission, as described in (a)(4) of this section
- (3) General measures: ...to avoid collisions with humpback whales, vessels must operate at a slow, safe speed when near a humpback whale. “Safe speed” has the same meaning as the term is defined in 33 U.S.C. 2006 and the International Regulations for Preventing Collisions at Sea 1772 (See U. S. C. 1602) with respect to avoiding collisions with humpback whales.

Mitigation Stipulations and Measures for Seismic Operations. The standard stipulations for MMS-permitted geological and geophysical (G&G) activities (Appendix K) would apply to all OCS seismic survey activities considered under this EIS. On-lease, ancillary seismic activities would use a selected suite of these mitigation measures that are appropriate for the specific operation.

Additional measures based on the protective measures in MMS’ most recent marine seismic-survey exploration permits and the MMS’ Biological Evaluation for ESA Section 7 consultation with NMFS on Arctic Region OCS activities dated March 3, 2006 (USDOJ, MMS, 2006c), recent Section 7 consultations with the FWS regarding threatened eiders, and the *Programmatic Environmental Assessment of Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006* (USDOJ, MMS, 2006a) would also apply to all OCS seismic survey activities. These measures are provided in Appendix K. These protective measures (e.g., ramp up) are accepted by the scientific community and the resource agencies (e.g., NMFS and FWS). Although not empirically proven, anecdotal evidence on the displacement of marine mammals by sounds (e.g., those sounds generated by ramp up) and professional reasoning indicate that they are reasonable mitigation measures to implement.

Depending on the environmental issues and analysis associated with an individual seismic survey or with multiple seismic surveys, additional mitigation measures (Appendix G) may be selectively incorporated in Incidental Take Authorizations issued by either NMFS or FWS under Section 7 of the ESA or Letters of Authorization/Incidental Harassment Authorization (LOAs/IHAs) issued under the MMPA for activities under G&G exploration permits issued by MMS. These mitigation measures would function to provide further protection from the possibility for causing adverse environmental impacts in special situations. Any mitigation measures addressing impacts to marine mammals and threatened and endangered species identified in MMPA-related incidental take authorizations and/or Endangered Species Act-related reasonable and prudent alternatives would supersede any such related mitigation measures in the relevant MMS permit.

In addition, the 2008 ARBO (NMFS, 2008c) includes 14 specific conservation recommendations. The 208 ARBO can be viewed on the MMS website at http://www.mms.gov/alaska/ref/BioOpinions/2008_0717_bo.pdf. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, to be considered in planning and permitting actions or to develop information.

4.4.1.6.1.3. Cumulative Effects Under Alternative 1.

4.4.1.6.1.3.1. Anticipated Level of Effects from 2D/3D Seismic-Survey-Related Noise and Disturbance. There are existing Federal leases in OCS portions of the Beaufort Sea, and it is expected that leaseholders and others would conduct 2D/3D seismic surveys to evaluate the potential for oil and gas production in the future. These surveys would occur during the open-water period. Similarly, State leases occur and are proposed in the State waters of the Beaufort Sea as well as exploration activities in the Canadian Beaufort Sea. It is reasonable to expect similar seismic-survey activities in the future. Federal OCS, State, and Canadian seismic activities are subject to mitigation measures and terms of IHAs and agency mitigation to avoid or minimize effects so that adverse effects on endangered whales are negligible.

Continuation of 2006 and 2007 levels of 2D/3D seismic surveys likely would continue. These surveys are subject to required mitigation measures to avoid or minimize adverse effects to endangered whales in the Beaufort Sea. Negligible effects are anticipated from existing levels of 2D/3D seismic surveys, and no additional effects from OCS actions would be attributable to Alternative 1, No Lease Sale.

4.4.1.6.1.3.2. Anticipated Level of Effects from Noise from High-Resolution Seismic Surveys. There are existing State leases in State waters, Federal leases in OCS portions of the Beaufort Sea, and exploration licenses in the Canadian Beaufort Sea. It is expected that leaseholders and others would conduct high-resolution seismic surveys to evaluate State waters and the OCS for oil and gas exploration drilling, development, and production in the future. If potential commercial deposits are indicated, localized high-resolution seismic surveys would be expected to increase, as leaseholders evaluate and plan specific exploration, development, and production actions. High-resolution surveys would be expected to decline in localized areas, as production and transport facilities are completed.

Permitted postlease high-resolution surveys in the Beaufort Sea are expected to increase as potential prospects are investigated for oil and gas production potential and subsequently developed and produced. These surveys are subject to specific required mitigation measures to avoid or minimize adverse effects to endangered whales in the Beaufort Sea from multiple activities that collectively could affect endangered whale movement, foraging, seasonal migration, and subsistence-harvest opportunity. Specific mitigation and/or avoidance measures to reduce impacts to endangered whales to a negligible level would be required. No additive effects from the Alternative 1 are anticipated, because the Beaufort Sea Sale 209 and 217 related high-resolution surveys would not occur.

4.4.1.6.1.3.3. Anticipated Level of Effects from Vessel and Aircraft Traffic and Noise.

4.4.1.6.1.3.3.1. Anticipated Level of Effects of Noise from Icebreakers. Icebreakers introduce noise levels to the marine environment at greater levels than vessels not engaged with the high-intensity power needed for ice management. Bowhead whales would be the listed whale most sensitive to icebreaker activity, as the fin and humpback whales are not likely to be in ice-covered waters. Bowhead whale response to icebreaker noise usually is avoidance. Increased use of icebreakers over an expanding region of activity could expose more whales to more frequent short-term exposure to noise potentially

earlier and later in the ice-associated period of the year. Drillships often are attended by an icebreaker in the late fall as ice forms and assists in prolonging the drilling season. It is reasonable to anticipate that oil and gas exploration activities in the Canadian Beaufort Sea may use the support of icebreakers. Existing information indicates an increasing trend in amounts of vessel traffic associated with tourism and research cruises as well as interests investigating feasibility of shipping via the Northwest Passage. This trend is anticipated to continue into the foreseeable future. Icebreakers often are the primary research vessels, and icebreakers attend other vessels in transit during early portions of open-water periods and during the spring bowhead whale migration through the spring lead system. These vessels would be relatively free to navigate in areas where disturbance to bowhead whale concentrations of cows and calves could occur in the Beaufort or Chukchi lead systems.

Postlease exploration drillship activity likely would increase to two from current levels of zero in the Beaufort Sea to explore past and current leases. These likely would be attended by an icebreaker-class vessel in the late fall. Icebreakers attending drillships often mask the operating drillship noise when active. This would be a localized source of noise that migrating bowheads would avoid and potentially deflect from normal migration corridors. The effect would be short term and not have population-level effects. Required mitigation would avoid or minimize the effect of such activity on spring and fall whale migration so as to not interfere with the traditional availability of bowhead for subsistence hunts or concentrations of vulnerable cows and calves in the spring lead system. No additive icebreaker activity would result from Alternative 1.

4.4.1.6.1.3.3.2. Anticipated Level of Effects of Noise from Other Vessel Traffic and Noise.

Increase in vessel traffic is anticipated to occur for the same reasons as icebreaker activity trends, and involves increases tourism, research, military, and commercial-vessel traffic and supply fuel barges to villages. More frequent encounters with listed bowhead, fin, and humpback whales are likely to occur where whale habitats overlap vessel-travel corridors. Encounters involve higher potential for injury or mortality from vessel-whale collision or propeller strikes as well as the chronic increasing exposure to vessel noise and presence.

The vessel-related postlease activities likely would increase incrementally in the Beaufort Sea; however, required mitigation measures on vessels associated with oil and gas exploration and development activities avoid or minimize effects upon endangered whales. As a result, authorized vessel activity would have proportionately fewer impacts to endangered whales than unrestricted vessel operations. Anticipated effects could result in the injury or mortality of a few individual bowhead, humpback, or fin whales as result of vessel-whale contact. Noise-related effects are anticipated to be minor, temporary, and nonlethal.

4.4.1.6.1.3.3.3. Anticipated Level of Effects from Aircraft Traffic and Noise.

Increased air traffic from commercial or private aircraft operations is not anticipated to change in the OCS except nearshore, where air traffic related to freight and other commercial services may increase the frequency of straight-line flights over portions of the OCS. Oil- and gas-related support for postlease operations is expected to increase as exploration, development, and production phases occur on Beaufort Sea existing leases.

Required mitigation avoids or minimizes the effects of aircraft traffic and noise on endangered whales and other marine mammals. We acknowledge there may be incremental increases in numbers of support, crew transport, and monitoring flights; however, mitigation measures avoid adverse effects from aircraft activity. Effects from aircraft activity that is not subject to mitigation requirements would continue in nearshore areas providing habitat for endangered whales and that are subject to low-level overflights serving by a wide variety of non-OCS activities. The effects are anticipated to be minor.

4.4.1.6.1.3.4. Anticipated Level of Effects of Noise from Drilling Operations (placement, construction, drilling). Drilling the OCS leases is anticipated to increase as leaseholders explore potential productive oil and gas finds. Exploration drilling would likely involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible if development and production is pursued. If exploration drilling indicates development and production is feasible, drilling would be expected to continue at a rate determined by the number of drill rigs available.

Exploration drilling is anticipated to increase to two drillships operating in the Beaufort Sea on existing leases. These may drill at more than a single location in a given year. There currently are no drillships active in the Beaufort OCS; however, drilling has occurred in the past in the Beaufort Sea OCS. Drillship operations are subject to mitigation measures that avoid or eliminate adverse effects to endangered bowhead whales. Effects of drillship operations can cause slight deflection of some migrating whales from established migration corridors; however, the deflection is transitory and migration-corridor fidelity is reestablished after passage of a drillship after an avoidance deflection occurs. Mitigation measures would be required to avoid deflecting migrating whales away from subsistence-hunt areas when drillship location is east of subsistence hunting areas and periods avoid impacts to subsistence harvest opportunity. Similar mitigation would be applied should delineation and production wells be developed. Synergistic adverse effects as result of platform placement and construction, drilling, and other concurrent activities are avoided or minimized by application of mitigation measures that avoid or minimize the footprint of multiple activities relative to bowhead whale and other endangered whale biological activities and subsistence-hunt periods. No population-level effects and minor temporary, nonlethal effects are anticipated.

4.4.1.6.1.3.5. Anticipated Level of Effects of Noise From Oil and Gas Production Activities.

The current levels of State nearshore petroleum production, increased production from planned development of commercial petroleum discoveries, and continued production activity of the Northstar facility is anticipated. Existing monitoring data indicate minor effects on bowhead whales are anticipated from these activities. Effects on humpback whales are unknown at this time.

The current Northstar production activities and future incremental increased production activity from the Liberty production facilities and other existing lease discoveries that are determined to be commercially productive are reasonably anticipated to be developed and produced in the Beaufort OCS. Production activity noise related effects on endangered bowhead whales is anticipated to be one of slight avoidance response and deflection of some migrating whales. Vessel traffic and noise associated with production appears to be greater than the noise from production activity alone. Mitigation and monitoring measures 1. would be required to verify and maintain minimal effects to endangered whales. Minor, temporary, nonlethal effects to endangered whales are anticipated.

4.4.1.6.1.3.6. Anticipated Level of Effects of Noise from Facility Abandonment Activities.

Abandonment activities would be anticipated for production facilities when no longer capable of commercial production. Abandonment activities and associated noise are anticipated to be localized and short term and would involve State and OCS facilities and infrastructure.

Eventually, OCS production facilities and infrastructure facilities would be abandoned. Mitigation measures would be required to avoid or minimize effects to endangered whales and the subsistence hunt for bowhead whales on OCS leases. Minor temporary, nonlethal effects to endangered whales are anticipated.

4.4.1.6.1.3.7. Anticipated Level of Effects of Noise from Oil-Spill-Cleanup Activities. In the event of a large oil spill in the Beaufort Sea, it is reasonable to expect emergency response and cleanup

activities that would involve aircraft and vessel deployment. Refer to Sections 4.4.1.6.1.1.4 and 4.4.1.6.1.3.3 for discussion of potential and anticipated impacts to endangered whales from vessel and aircraft traffic and noise. Avoidance of active vessels and low-flying aircraft by endangered whales would serve to buffer whale contact with a spill, especially if in the spring lead system and if fresh oil with high concentrations of volatile aromatic hydrocarbons that would be potentially injurious or fatal to bowhead whale cows accompanied by very young calves. It is anticipated that, depending upon the location, timing, and circumstances of a spill, delayed spring bowhead migration and route alteration could occur for some whales. Much of the spring lead system in the Beaufort Sea is offshore of existing leases and sources of fresh spilled petroleum. Endangered whale avoidance of noise from spill cleanup vessel, aircraft and human activity in the open water season would serve to decrease contact with spilled petroleum but could alter use of preferred habitat or prey concentrations.

4.4.1.6.1.3.8. Anticipated Level of Effects from Discharges. Discharges related to drilling would occur and, if released into the marine environment, effects would remain localized in relation to affecting endangered whale habitat and prey populations. The effects of such discharges are anticipated to remain localized as a result of rapid deposition and dilution and potential contamination (if toxic contaminants are present in discharges) of an extremely small proportion of the habitat or the prey base available to endangered whales. Thus, for practical purposes population-level effects would be negligible.

Bottom-founded drilling units or gravel islands may inundate small areas of benthic habitat and seafloor that support epibenthic invertebrates that bowheads and other endangered whales feed on. Such effects would be negligible in relation to the available habitat in the Beaufort Sea. Turbidity or sediment suspension in marine waters as a result of gravel island construction, placement of fill, installation of gravel bags or sheetpile are not anticipated to affect bowhead whales. Such construction activities likely would occur in winter, when bowheads are not present and in the open-water periods before the fall migration. Anticipated effects on fin and humpback whales are unknown.

Exploration drilling on past and existing leases would add incrementally to the potential discharges into the Beaufort Sea and would remain localized to the immediate areas of OCS exploration drilling activity. Mitigation measures likely would require that discharges from delineation and development wells not be discharged into marine waters but be treated and disposed of by other means.

4.4.1.6.1.3.9. Anticipated Level of Effects from Large and Small Oil Spills. Potential effects of oil spills on endangered whales are discussed in Section 4.4.1.6.1.1.11. Fresh oil spills with high concentrations of volatile aromatic hydrocarbons into marine waters associated with the spring lead system, and the large numbers of bowhead whales migrating through the lead system, present the greatest potential for effects to large numbers of bowhead whales and vulnerable newborn calves. Spill records indicate accidental oil spills in Alaska occur in harbors and during groundings. Vessel-related spills on the high seas are considered infrequent. Concern has been expressed of increasing tourism and shipping vessel traffic between the Bering Sea and the North Atlantic, especially vessels and by crews unaccustomed or ill-prepared for these remote and dangerous areas. Vessels transiting the Beaufort or Chukchi seas during ice periods are more prone to accidents. The ADEC (2007) reports the highest probability of spills of noncrude products occurs during fuel-transfer operations at remote villages.

No large spills are anticipated to occur during exploration activities in the Beaufort Sea. Development and production projects and associated infrastructure for product transport may occur on existing leases and in the Beaufort Sea OCS in addition to the Northstar and ongoing Liberty projects. It is anticipated that in the unlikely event of a large oil spill, some individual bowhead whales may experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number affected likely would be small. Some individual whales could experience skin contact with oil, baleen fouling,

inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum-contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Anticipated effects of exposure of endangered whales to spilled oil may result in lethal effects to a few individuals, and most individuals exposed to spilled oil likely would experience temporary, nonlethal effects.

4.4.1.6.1.3.10. Anticipated Level of Effects from Subsistence Hunting. Potential effects of the closely regulated subsistence harvest of bowhead whales are discussed in Section 4.4.1.6.1.1.12. The harvest of bowhead whales for subsistence purposes would remain the major known human-caused mortality and is expected to continue at the current levels until 2012, at which time subsistence-harvest quotas may be revisited by the IWC. Humpback and fin whales are not subject to harvest and are not expected to be so in the future.

Activities from Alternative 1 are not anticipated to contribute any effects on subsistence activities and the harvest of bowhead whales. If additional recoverable oil and gas resources are discovered and produced from existing leases in the Beaufort Sea, subsistence hunting of endangered bowhead whales would continue. Depending on where discovery and production activities occur, required mitigation measures would ensure whale movement into harvest areas, interference with subsistence-hunting activities, and opportunity to harvest bowhead whales are not impaired by OCS actions. The OCS activities are not anticipated to alter the subsistence harvest or the vulnerability of bowhead whales to harvest.

4.4.1.6.1.3.11. Anticipated Level of Effects from Changes in the Physical Environment. Trends in arctic warming are anticipated to continue. Potential or predicted effects are discussed in Section 4.4.1.6.1.1.14. Direct and indirect effects of warming of the Arctic remain speculative as to timing, magnitude, and intensity. Continuing monitoring, evaluation, and appropriate ESA Section 7 consultation procedures will allow MMS and others to adjust activities as appropriate to protect endangered whales.

Summary - Effects Under Alternative 1.

4.4.1.6.1.4. Direct and Indirect Impacts Under Alternative 1 (No Lease Sale). No direct or indirect effects to bowhead, fin, or humpback whales or their habitats would occur from activities related to Lease Sale 209 or 217 if these sales are not conducted. No additional direct or indirect vessel traffic, noise, oil spills, discharges, or other effects would occur if Lease Sale 209 or 217 were not conducted. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.6.1.4.1. Cumulative Impacts Under Alternative 1.

Summary. The effects of offshore oil and gas operations on endangered whales have been assessed in a number of documents including a Biological Evaluation, the Five Year Programmatic EIS (USDOJ, MMS, 2007c), an ESA biological opinion (BO) and an authorization for small takes (USDOC, NOAA, 2006a,b), the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), and environmental assessments for Lease Sales 195 and 202 (USDOJ, MMS, 2004, 2006b).

If the proposed lease sale is not held, there are past and existing environmental changes and conditions that may be sources of adverse effects to bowhead and humpback whales, and these are expected to persist. Many of these are beyond the authority of MMS to control, and some endangered whales and populations could be adversely affected over the next 30 years. Past and existing OCS activities and previous assessments not associated with Lease Sale 209 or 217 include mitigation measures. Activities

beyond MMS authority may or may not be subject to mitigation measures or, in the case of climate change, not be subject to direct mitigation measures.

Cumulative effects of Alternative 1 (No Lease Sale) on current status and trend of endangered bowhead and humpback whales associated with the Reasonably Foreseeable Future scenario (Section 2.4) would be the following:

- The bowhead population is subject to an annual regulated harvest by Alaskan Natives and other mortality. Subsistence harvest of bowhead whales is likely to continue at current levels and, if the population continues to recover at current rates, additional subsistence harvest could be allocated. The western Arctic bowhead stock has been increasing in recent years; the current estimate is between 19% and 105% of the pre-exploitation abundance, and this stock may now be approaching its carrying capacity (Brandon and Wade 2004). Current bowhead whale population-trend analysis indicates a 1978-1993 rate of increase of 3.1% and, including 2001 data, a 3.4% (George, 2004) or 3.5% (Brandon and Wade, 2004) rate of increase. This rate of increase does not include data from 2002-2007; however, the period considered in the analyses covers periods of OCS activities as well as activities and environmental changes beyond the authority of MMS and indicates a healthy and increasing population. Traditional subsistence harvest by Alaskan Natives could be interrupted or become terminated due to changes in bowhead whale habitat use, movement pattern shifts, and availability that result in unsafe and inefficient distances to obtain harvest. This potentially could result in modification of subsistence methods, timing, and technology.
- The estimated annual mortality incidental to U.S. commercial fisheries (0.2) is not known to exceed 10%, or 9.4 animals, of the annual potential biological removal (PBR), and the annual level of human-caused mortality and serious injury is not known to exceed the PBR (95) or the IWC maximum (67). If fisheries in the Beaufort Sea improve to the level that commercial fishing is allowed in the Arctic, a slight increase in entanglement in fishing gear could be expected.
- Climate change may be modifying distribution and productivity of bowhead and other endangered baleen whale prey and, thereby, may be modifying carrying capacity and distribution of endangered whales. Such effects could be either positive or adverse, but remain speculative at this time. Diligent monitoring and timely data analysis is important to detecting adverse changes in the bowhead population productivity, abundance, distribution, movement, and mortality. Until such analysis indicates bowhead population and habitat-use patterns are adverse to the existing conditions, it is expected that the current situation indicating a healthy and robust population of bowhead whales will continue relative to Alternative 1. Information on humpback and fin whales remains insufficient to draw conclusions; however, new evidence of unprecedented humpback occurrence in the Beaufort and Chukchi seas is likely indicative of ongoing change in the ocean environment under existing conditions and trends expected to continue with implementation of Alternative 1. Traditional subsistence harvest by Alaskan Natives could be interrupted or become terminated due to changes in bowhead whale habitat use, movement pattern shifts, and availability that result in unsafe and inefficient distances to obtain harvest. This potentially could result in modification of subsistence methods, timing, and technology.
- Longer ice-free seasons and broader ice-free areas could result in new vessel shipping patterns (Northwest Passage and over the North Pole from European routes) that may disturb whale-habitat use in large areas of off shore waters previously with no or very little disturbance or presence of vessel traffic and associated noise. Previous and present shipping patterns confine the majority of vessel traffic to nearshore support for local communities and nearshore and onshore industrial activities. Future nearshore traffic could increase as the region responds to increased accessibility, shipping opportunity, development opportunity, and infrastructure needs. Increased shipping traffic, icebreaking support for shipping, military and regulatory vessels traffic, commercial fishing, recreation (cruise ships), research and uncontrolled aircraft and vessel

noise are expected, as current trends regarding climate change and economic opportunity continue.

- Increased vessel-traffic levels and expanding routes of vessel traffic could create opportunity for greater incidence of injury or mortality of endangered whales via collisions and propeller contact.
- Increased vessel activity could increase the chance of fuel spills from vessels. Increasing bulk-fuel needs and transport could result in higher chance of a large fuel spill and, although individual whales could be injured or mortality result, population-level effects could occur in the specific circumstances presented in the spring lead system during calving and migration. Exposure of concentrations of bowhead whale females with calves to fumes could result in substantial loss or injury, especially of the young of the year.
- Climate change could either intensify interspecific and intraspecific competition for prime feeding areas and prey or expand available habitat resources among bowhead, gray, and humpback whales. Expansion of regional habitat use and abundance by orcas, a potential predator of baleen whales may increase with climate changes and subsequent ocean ecosystem changes.
- Changing conditions potentially could provide opportunity for exotic or invasive species of marine life to expand into the Chukchi or Beaufort sea, and potential pathogens and parasites previously absent in the Arctic could survive and affect Arctic species lacking resistance or immunity.
- Humpback whale habitat may be enhanced by longer ice-free periods and greater expanses of ocean, where prey bases are enhanced by changing oceanographic conditions. Humpbacks could expand their range, numbers, and duration of presence in the Beaufort and Chukchi seas. The same condition could at some point expand fin whales over a wider range in the Chukchi and possibly into the Beaufort Sea.
- Spatial and temporal changes of ice-cover duration, movement, age, and thickness could alter the distribution, timing, and patterns of the spring lead system, bowhead migration timing and movement efficiency through ice conditions, seasonal-use areas, and prey productivity and distribution in both the Chukchi and Beaufort seas.

The cumulative interaction of ongoing or existing activities and climate change processes may or may not adversely affect endangered whales, depending on the complex temporal, spatial, magnitude, rate of change, and many more variables that are unpredictable at this time. Climate change may create positive and/or negative effects to endangered whales. How such potential changes would occur singly or in combination would be highly speculative at this time. Continued intensive monitoring effort would be necessary to document changes and effects and develop responsive management, as appropriate. Increased human-caused activities could deflect and possibly alter nearshore spring and fall bowhead whale migration corridors that, in turn, may or may not adversely affect whales, their habitat, and human use of the whale resource. Such traffic could prevent effective duration of use or prevent bowhead and other endangered whale access to high-quality prey concentrations. Frequent encounters and exposure to noise disturbance could reach levels of chronic and cumulative stress to some animals that could impact health, social bonds, and productivity of individuals and potentially populations.

There would be no small or large oil- and gas-related spills attributed to Alternative 1, as Lease Sale 209 or 217 would not occur. Spills associated with OCS prelease activities and existing lease activity could occur as well as spills from those past, present, and foreseeable activities (e.g., shipping, military operations, cruise-ship activity, refueling, vessel collision and grounding, State oil and gas activity, aircraft crashes, etc.) not authorized by the Alaska OCS Region. Analysis of OCS spill probabilities and response has been analyzed in previous documents (USDOI, MMS, 2003a; NMFS, 2006) for past and existing OCS activities in the Beaufort and Chukchi seas. Most whales exposed to spilled oil are expected to experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon

vapors, ingestion of oil-contaminated prey items, baleen fouling, reduced food resources, or temporary displacement from feeding areas. A few individuals may be killed, temporarily or permanently experience sensory or physical impairment, or tissue contamination as a result of exposure to freshly spilled oil; however, the chance of one or more large spills occurring and also contacting whale habitat during the periods when whales are present is considered low. Whales tend to avoid spill-cleanup-vessel traffic, noise, and human activity, and the percentage of Western Arctic stock affected is expected to be very low. The chance of an oil/fuel spill may increase with more and broader regional distribution of oil- and gas-related activity, nonshipping vessel activity, refueling events, increased vessel transport of fuel and goods, and other activities or events that can result in spilled oil. Potential climate change-induced increases in numbers, changes and/or expansion in seasonal distribution and range by North West Pacific humpback and Western Arctic bowhead whales also could increase potential exposure of whales to oil in the event of spills, depending on the circumstances of a spill event.

Mitigation measures associated with foreseeable (without Lease Sale 209) OCS exploration, development and production upon existing offshore lease areas are expected to minimize adverse effects to whale migration corridor use at key periods, minimize interference with availability of bowhead whales for subsistence hunts, and endangered whale use of important seasonal habitats and feeding areas. Monitoring of endangered whales would continue to document and provide data regarding climate change-induced alterations of whale populations, ecology, and human use from which to formulate and implement informed and adaptive decisions.

4.4.1.6.2. Threatened and Endangered Birds.

Summary. In the following analysis, we determined that there would be no direct or indirect effects if the lease sales were not held; there would be a negligible cumulative level of effect from seismic surveys and petroleum spills; and a continued minor cumulative level of effect from vessel presence and noise, aircraft presence and noise, subsistence hunting, collisions with structures, loss of habitat, and increased predator populations. The greatest potential for a major level of effect is associated with continuing physical changes in the arctic environment. Mitigation measures imposed by MMS on future exploration and development activities on existing leases or surrounding waters avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. The total effect of MMS-authorized actions would be proportionately lower when compared to similar but unrestricted activities in the area.

Threatened and endangered birds in the Chukchi and Beaufort seas include the Steller's eider (threatened) and spectacled eider (threatened). The Kittlitz's murrelet is a candidate species (Listing Priority Number 2). The FWS defines a candidate species as: "...one for which we have sufficient information to prepare a proposed rule to list it, because it is in danger of extinction or likely to become endangered within the foreseeable future throughout all or a significant portion of its range." We included the Kittlitz's murrelet because it may be proposed for listing or be listed in the reasonably foreseeable future. We often refer to these species collectively as ESA-listed or ESA-protected birds.

In the following analysis, we describe the potential effects to threatened and endangered birds (and marine and coastal birds in general) from a variety of existing sources (Section 4.4.1.6.2.1). We then identify mitigation measures that would avoid or minimize some of these impacts (Section 4.4.1.6.2.2). The resultant anticipated level of effect is determined for this alternative on each species of threatened and endangered birds (Section 4.4.1.6.2.3). These effects are broken down between direct and indirect effects of implementing the alternative (Section 4.4.1.6.2.3.1) and other cumulative effects reasonably likely to occur in the foreseeable future (Section 4.4.1.6.2.3.2). As threatened and endangered birds are a resource group, we address differential effects to each species separately in Section 4.4.1.6.2.4.

4.4.1.6.2.1. Potential Effects to Threatened and Endangered Birds. The principal sources of potential adverse effects to birds in the Beaufort and Chukchi seas include:

- vessel presence and noise;
- aircraft presence and noise;
- collisions;
- petroleum spills;
- increased bird predator populations;
- increased subsistence-hunting activity;
- habitat loss;
- seismic airgun noise; and
- changes in the physical environment.

These adverse effects are associated with community development; transportation; tourism; oil and gas exploration and development on private, State, and Federal lands; and climate change. Oil- and gas-exploration activities include vessel presence and noise, aircraft presence and noise, collisions, and seismic-airgun noise. Other than the pending Liberty and existing Endicott, Northstar and Oooguruk developments, production of oil or gas from existing leases in the Chukchi and Beaufort seas is speculative. Oil and gas development activities include those of exploration (to differing degrees) and increased bird predator populations, hunting, habitat loss, and petroleum spills.

4.4.1.6.2.1.1. Potential Effects from Vessel Presence and Noise. How waterfowl and marine birds respond to disturbances can vary widely depending on the species, time of year, disturbance source, habituation, and other factors (Fox and Madsen, 1997). It seems that in some species of waterfowl, the distance at which disturbances will be tolerated varies depending on flock size, because larger flocks react at greater distances than smaller flocks (Madsen, 1985). There is an energetic cost to moving away from a disturbance as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Vessels might disturb waterfowl and marine birds that are foraging or resting at sea or, in the case of a few species, molting at sea.

Disturbance is most likely to have an impact during those periods of the annual cycle when birds have difficulty in meeting their daily energy requirements, especially when food intake needs to be high to enable birds to build up nutrient reserves in advance of periods of high demand. Frequent disturbance could result in energy expenditures that prolong the molt beyond the ice-free period or decrease the amount of stored energy reserves available for winter survival. The condition of some species during the winter period likely influences subsequent reproduction. Madsen (1994) studied the long-term effects of hunting disturbance on pink-footed geese (*Anser brachyrhynchus*) and found that geese that had used undisturbed sites reproduced better than geese from disturbed sites.

The overall effect on some bird populations includes the periodic interruption of migrating postbreeding and molting eiders. For example, most spectacled eiders breeding on the Arctic Coastal Plain (ACP) make regular use of the lease-sale areas, and each sex/age cohort could be affected differently, depending on time and location. In the most extreme case, an estimated 33,200 spectacled eiders have been counted in the Ledyard Bay Critical Habitat Area (Figure 3.3.4.2-1) during the latter portion of the molting season. As most of these eiders are believed to be successfully breeding females and their hatch-year broods, even a seemingly trivial incremental degree of adverse effect to individual fitness (caused by chronic vessel disturbance) applied to such a large number of birds could result in decreased winter survival with resultant decreased population size, productivity, and recruitment.

4.4.1.6.2.1.2. Potential Effects from Aircraft Presence and Noise. Low-level helicopter or other aircraft traffic could adversely affect birds on the North Slope and coastal areas by (1) displacing adults

and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. Aircraft flights could force large numbers of birds to interrupt feeding to either dive or move away from an important foraging site to a site of lower prey availability in response to the approaching aircraft. Negative effects could result if an expenditure of energy during a physiologically-demanding period of egg production, broodrearing, or feather growth and the accumulation of energy reserves needed for later migration to wintering areas. Ward and Sharp (1974) assessed the impacts of helicopter overflights on molting long-tailed ducks and surf scoters at Herschel Island, Yukon Territory in August 1973. They found that all but 8% of long-tailed ducks and 2% of surf scoters reacted to the helicopter disturbance. While most molting ducks swam away from the helicopter, the rest that reacted dove underwater in response to helicopter approach. The reaction of these sea ducks to low-level flights indicated an interruption of normal behavior (such as cessation of foraging or sleeping) or displacement from foraging areas.

Lehnhausen and Quinlan (1981) observed low-flying aircraft disturbing common eider nesting colonies on barrier islands, flushing birds off their nests in “mass panic flights.” The authors speculate that gulls and jaegers (“...constantly flying over [the colony]”) preyed on the nests while the adults are away, resulting in decreased nesting success. Low-flying aircraft also could impact sensitive species, such as brant feeding and resting in coastal saltmarshes or long-tailed ducks molting in coastal lagoons (Lehnhausen and Quinlan 1981).

Helicopter and fixed-wing aircraft accounted for 67% and 33% of all flyover disturbance at a murre colony in coastal California (1997-1999; Rojek et al., 2007). These disturbances resulted in flushing of adult common murres. Flushing during incubation or chick-rearing periods can lead to egg or chick loss because of displacement from the breeding site, egg breakage or depredation by avian predators such as ravens or gulls. Rojek et al. (2007) suggested that murres are more prone to flushing in the pre-egg and early egg-laying periods than after egg-laying is well under way.

The behavioral response of eiders to low-level aircraft flights is variable; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate frequent aircraft noise. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport. Some birds may be displaced, with unknown physiological and reproductive consequences.

Disturbance to nesting spectacled and Steller’s eiders is probably limited due to their extremely low densities across the North Slope. Across the ACP of the North Slope, breeding-season density averages approximately one pair per 8 km² for spectacled eiders (Larned, Stehn, and Platte 2003). Steller’s eiders are so rare in some years, that they are not detected at all by aerial-survey methods. In the core of the Steller’s eider breeding area near Barrow, the highest nesting density recorded during 4 years of aerial surveys was estimated as approximately one pair per 12.5 km² (Ritchie and King, 2002). Densities elsewhere on the ACP are much lower.

Altitude restrictions have been used to separate birds and aircraft to reduce the potential to harm eiders (USDOI, MMS, 2006a). Altitude restrictions often are impracticable in arctic coastal areas, however, due to frequent inclement weather. Also, evidence suggests that some birds may habituate to certain sources of disturbance or avoid impacts associated with certain areas (USDOI, FWS 2005). The use of designated flight paths could allow many birds, especially those in a specific area over several weeks or returning to a specific area year after year, to habituate to or use alternative areas to avoid aircraft impacts.

4.4.1.6.2.1.3. Potential Effects from Collisions. Collisions could result from aircraft striking birds and birds striking vessels or offshore/onshore facilities.

Aircraft Striking Birds. Helicopter and fixed-wing aircraft operating at low altitudes have the potential to flush birds into the path of the aircraft, where a collision could occur. Approximately 90% of aircraft/bird collisions occur <1,500 ft above ground (Sodhi, 2002). Larned and Tiplady (1997) reported that flocks of wintering eiders often took flight during fixed-wing aircraft approaches of 150-200 m. While such strikes are relatively rare, aircraft/bird collisions could threaten the safety of aircraft/passengers and result in deaths of birds. Altitude restrictions have been used to separate birds and aircraft to reduce the potential harm to aircraft and birds (USDOI, MMS, 2006a).

Birds Striking Vessels. Migrating birds colliding with vessels have been well documented. Weather conditions such as storms associated with rain, snow, icing, and fog or low clouds at the time of the occurrences often are attributed as causal factors (Weir, 1976; Brown, 1993). Lighting of structures, which can be intensified by fog or rain, also has been identified as a factor (Avery et al., 1980; Brown, 1993; Jehl, 1993). Birds are attracted to the lights, become disoriented, and may collide with the light-support structure (e.g., pole, tower, or vessel hull or superstructure).

Lights on fishing vessels at sea have been known to attract large numbers of seabirds during storms (Dick and Donaldson, 1978). Black (2005) reported a collision of about 900 birds, mostly a variety of petrel species and Antarctic prion, with a 75-m fishing trawler near South Georgia. The collisions took place over a 6-hour period at night, when visibility was <1 nautical mile (nmi), due to fog and rain. Of the 900 birds on deck, 215 were dead. Most of the remaining birds were released alive after being allowed to dry off in boxes stored in a protected area on deck. Waterfowl and shorebirds also have been documented as colliding with lighted structures and boats at sea (Schorger, 1952; Day et al., 2003). High-intensity lights are needed by vessels during some nighttime operations, or when visibility is hampered by rain or fog.

Marine birds risk collisions with vessels at night due to attraction and subsequent disorientation from high-intensity lights. Sea ducks are particularly vulnerable to collisions with vessels, primarily because they tend to fly low over the water. Johnson and Richardson (1982) documented that 88% of eiders migrating to molting areas along the Beaufort Sea coast flew below an estimated 10 m (32 ft), and over 50% flew below 5 m (16 ft). Eiders leaving the North Slope travel day or night. Movement rates (birds/hour) did not differ between night and day, but movement rates and velocities were higher on nights with good visibility (Day et al., 2004).

Birds Striking Other Facilities. Birds can be killed by collisions with onshore and offshore structures (i.e., communication towers with support cables, overhead power lines, drilling structures, etc.). Eiders may be particularly vulnerable due to their flight behavior; they travel in relatively large flocks (~110 birds/flock), they fly fast (~83 km/hour), they fly low (5-12 m above sea level), and they tend to migrate in straight lines (~98% of observed flocks) (Day et al., 2005, 2004). A number of factors may reduce the height at which eiders migrate, including wind speed and direction, weather (i.e., fog or rain), and lighting (day vs. night) conditions (Day et al., 2005).

Day et al. (2005) completed a 4-year study of bird migration and collision avoidance at Northstar Island. The authors used bird radar to assess the reaction of migrating eiders and other birds to collision-avoidance lights located on the production structure. The authors reported that the lights were not so strong that they disrupted eider migration, but the lights caused eiders to slow down and alter their flight paths away from the island.

Collision-related mortality to birds on the North Slope is difficult to estimate due to factors including:

- habitat effects, number of birds actually recovered likely vary relative to habitat;
- observer bias, different observers have different probabilities of actually recovering carcasses;

- scavenging bias, carcass longevity likely varies relative to local predator composition and abundance; and
- crippling bias, injured birds may walk or fly away from the collision site and die.

Thirty common eiders, 6 king eiders, and 13 long-tailed ducks were killed due to collisions with Northstar and Endicott islands in the Alaskan Beaufort Sea during fall migrations in 2001-2004 (Day et al., 2005). This total was collected over a relatively narrow window (80 days total spread over 4 years) of the fall migration and, thus, probably underestimates total collision loss during fall migration.

The greatest potential for collision impacts occurs where structures are within nearshore areas where birds, particularly eiders and long-tailed ducks, are known to migrate (Figure 3.3.5-2). Light radiated upward and outward from structures could disorient flocks of eiders and other birds during periods of darkness or inclement weather, when the moon is obscured. If migrating birds were not disoriented by radiated light, they still could encounter structures in their flight paths. Making surfaces visible to approaching birds may slow flight speed, allowing them to maneuver past collision hazards. Inward-directed lighting would illuminate these surfaces, but surface textures that absorb, rather than reflect, light could maximize visibility to closely approaching birds and minimize disorientation of distant birds during periods of darkness or inclement weather, when the moon is obscured.

4.4.1.6.2.1.4. Potential Effects from Petroleum Spills. Exposure of birds to petroleum could result from a number of ongoing or future activities. These include vessel sinkings or accidents, equipment malfunctions during bulk fuel transfers, and during oil and gas exploration and development. Spilled fuel/oil in the Chukchi Sea or Beaufort Sea would be a serious threat to birds because it forms a thin liquid layer on the water surface. Bird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage and inability to fly or forage (Fry and Lowenstine, 1985). Alcids and sea ducks are highly vulnerable to oil spills, because they spend most of their time on the sea surface and aggregate in dense flocks. In the event of a spill, birds could die due to the following direct and indirect effects:

Covering of Skin or Feathers. Fouled plumage is the primary cause of mortality and stress in oiled birds (Burger and Fry, 1993). The hydrophobic nature of petroleum hydrocarbons makes them interactive with the hydrophobic properties of bird feathers. Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage. Oiled feathers lose their ability to keep body heat in and cold water out, and resultant hypothermia can kill birds. Waterlogging and loss of buoyancy can rapidly lead to drowning.

Inhaling Hydrocarbon Vapors. Birds have the most efficient respiratory system of all vertebrates (Welty, 1975) and could be more susceptible to harm from inhaling hydrocarbon vapors than mammals. The following conclusions are based on Geraci and St. Aubin (1982) as applied to birds. Inhaled petroleum vapors are absorbed into the bloodstream and carried throughout the body. Inhalation of highly concentrated petroleum vapors can lead to inflammation and damage of the mucous membranes of the airways, lung congestion, emphysema, pneumonia, hemorrhage, and death. It is unlikely that vapor concentrations can reach critical levels for more than a few hours. If a bird were unable to leave the immediate area of the source of the spill or were confined to a contaminated lead or bay, it could inhale enough vapors to cause some damage. Birds away from the immediate spill area or exposed to weathered or residual oils would not be expected to suffer any adverse effects from vapor inhalation.

Ingesting Oil or Contaminated Prey. Petroleum oils contain many toxic compounds that can have fatal or debilitating effects on birds when ingested (Burger and Fry, 1993). Both crude and bunker oils produced intestinal irritation in birds. Oils with high polyaromatic hydrocarbon contents are known to cause precipitation of hemoglobin leading to anemia. In experiments with two species of marine birds,

Leighton et al. (1983) found that severe hemolytic anemias occurred from ingestion of large amounts of crude oil.

The major route by which birds would be expected to ingest oils is by preening it off their feathers after exposure. These same toxic compounds could be absorbed through the skin.

There are numerous other routes of injury to birds from ingested oil (Burger and Fry, 1993). The osmotic regulation of blood and tissue fluids is influenced by several organs, including intestines, kidneys, and salt glands, which might be susceptible to oil toxicity. Osmotic stress can be fatal, or can exacerbate the effects of shock and cold stress in oiled birds. Significant changes in the size of the adrenal glands and levels of corticosteroids have been found in several studies where small amounts of oil were fed to birds. Liver and kidney damage was reported as direct effects of crude and fuel oil ingestion in several studies on birds. Ingestion of oils can reduce the functions of the immune system and reduce resistance to infectious diseases.

Additionally, food may be contaminated either directly or by hydrocarbons within the food chain.

Reproductive Effects. Ingested oil causes short- and long-term reproductive failure in birds, indicative of severe physiological problems. These include delayed maturation of ovaries, altered hormone levels, thinning of eggshells, reduced egg productivity, reduced survival of embryos and chicks, reduced chick growth, and abandonment of nests by adults (Burger and Fry, 1993). Cassin's auklets experienced reduced reproduction after exposure to Prudhoe Bay crude oil (Ainley et al., 1981). It is unknown if exposed adults could become permanently sterilized.

If adults engaged in a futile attempt to hatch a dead embryo, their reproductive effort for that year would be lost. Even if they were to attempt to re-nest later in the season, it is doubtful that their late-hatching young would survive. Some species, such as Kittlitz's murrelets, typically raise only one chick per year.

Both parents of some species incubate eggs and bring fish for their young. Lightly oiled birds could bring oil contamination back to their nest where eggs and young could be contaminated. Lightly oiled birds also could bring contaminated food to the nest. Heavily oiled birds would be prevented from returning to the nest resulting in the young dying of starvation.

Reduced Food Sources. Food resources used by birds could be displaced from important habitats or be reduced following a petroleum spill. Benthic habitats that support marine invertebrates, however, would not be expected to experience substantial adverse effects following a spill.

Displacement from Feeding or Molting Areas. The presence of substantial numbers of workers, boats, and aircraft activity between the spill site and support facilities is likely to displace birds foraging in affected offshore or nearshore habitats during open-water periods for one to several seasons. Disturbance during the initial response season, possibly lasting as long as 6 months, is likely to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging birds.

Activities such as hazing and other human activities (boat and air traffic) could disturb birds in the nearshore environment. Hazing may have limited success during spring, when migrants occupy open-water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to adversely affect marine and coastal birds, including birds in coastal areas.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal-deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with FWS and State officials on wildlife management activities in the event of a spill. In an actual spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, FWS personnel would be largely responsible for providing critical information affecting response activities to protect migratory birds in the event of a spill.

4.4.1.6.2.1.4.1. Chronic Low-Volume Spills. Beached-bird surveys have demonstrated that low-volume, chronic oil pollution is an ongoing source of mortality in coastal regions (Burger and Fry, 1993). Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. In cold climates, an oil spot the size of a square inch is enough to compromise water repellency of plumage, possibly leading to the death of a bird. In some places, low-volume, chronic oiling is a major cause of seabird mortality.

Summary of Potential Spill Effects. Direct oil/fuel contamination of birds likely would result in loss of feather insulation and acute and chronic toxicity from ingestion and absorption. Oiled birds also could carry oil to nests where eggs and young could be oiled. The combined effects of oiled plumage, osmotic and thermal stress, and anemia greatly could increase the mortality of birds under adverse environmental conditions. Spilled oil can originate from a variety of sources and be in the form of a large spill, small spill or chronic small spills. Research indicates that while larger spills have more immediate mortality, the combined mortality from chronic smaller spills could surpass the effects from a large spill.

4.4.1.6.2.1.5. Potential Effects from Increased Bird Predator Populations. Predation is believed to be a principal cause for nesting failure. Predators of marine and coastal birds along the Chukchi and Beaufort seas include snowy owls, peregrine falcons, gyrfalcon, pomarine and long-tailed jaegers, rough-legged hawks, common ravens, glaucous gulls, and arctic and red foxes. Primary predators are foxes, gulls, and ravens. The current distribution and abundance of these predators are unknown, but ravens, for example, have existed commensally with small communities or structures across the North Slope for decades (see Day, 1998). Other species, especially raptors, are young, dispersing birds transiting the area after the breeding season.

Several of these bird predators that prey on waterfowl eggs and young concentrate in areas where human-use foods and garbage are available. Examples include gulls, ravens, and arctic foxes that are abundant near camps, roads, oilfields and villages. For ravens and foxes, there is evidence indicating population increases and range expansion due to increased availability of nesting or denning sites on these developments where they did not previously exist.

The predation pressure that foxes, gulls, and ravens exert on nesting birds, especially waterfowl, is well documented and, in some areas, predation is the predominant factor affecting nest success. The greatest direct impact on marine and coastal bird populations would occur when predator densities are high and densities of nesting birds are low. Excessive predation on nesting females also can result in imbalanced sex ratios within populations. Increased predation poses a potentially major adverse impact to bird populations on the North Slope.

4.4.1.6.2.1.6. Potential Effects from Increased Subsistence-Hunting Activity. Alaskan Natives traditionally have harvested a wide variety of birds on the North Slope. While this harvest continues under State and Federal regulations, some species cannot be harvested because their populations have declined to low levels. Subsistence-harvest surveys for the North Slope indicate that an

average of 155 spectacled eiders were taken at Wainwright during 1988-1989, and only 2 spectacled eiders were reported taken in Barrow during 1987-1990 (S.R. Braund and Assocs., 1993a,b). Some accidental harvest of protected species is believed to occur through misidentification.

4.4.1.6.2.1.7. Potential Effects from Habitat Loss. Habitat loss occurs as facilities are developed, covering tundra habitats used by birds for nesting, foraging, broodrearing, and molting. Hundreds of acres of North Slope bird habitats have been filled by oil and gas infrastructure (fill pads, pipelines, roads, gravel pits, etc.), as well as community development (residences, schools, airports, roads, landfills, etc.). Secondary impacts occur from altered hydrology associated with these facilities, flooding areas and drying others. While some species may have or will benefit from wetter or drier habitats near these facilities, evidence suggests that many birds avoid using habitats near these developments and the human activities they support. For example, regular vehicle traffic on roads could result in the permanent displacement of nesting birds in a zone of influence around this development.

4.4.1.6.2.1.8. Potential Effects from Seismic-Airgun Noise. Oil and gas resources need to be identified and delineated before they can be developed. Most often this assessment is completed using seismic techniques. Because seismic surveys completed on land are completed during winter months, direct effects to birds are few. For purposes of analysis in this EIS, we assess the potential effects of vessel-based seismic surveys in marine areas of the Chukchi and Beaufort seas. The primary effects could arise from airgun noise.

Seismic surveying with airgun arrays results in both vertical and horizontal sound propagation. Horizontal propagation is a relevant issue, because it is less likely that marine birds would be under the array. Although there is variation in attenuation rates depending on bottom slope and composition, sound from airgun arrays can be detected using hydrophones at ranges of 50-75 km in water 25-50 m deep (Richardson et al. 1995).

Few studies have assessed the effects of seismic surveys on marine birds and waterfowl. Stemp (1985) observed responses of northern fulmars, black-legged kittiwakes, and thick-billed murres to seismic activities in Davis Strait offshore of Baffin Island. The first 2 years of the study involved the use of explosives (dynamite gel or slurry explosives) and, therefore, are not relevant, as use of underwater explosives are not anticipated being used for seismic surveys in the lease-sale area. The final year of the study involved airguns, but the study locations were never in sight of colonies, feeding concentrations, or flightless murres. The results of this study did not indicate that seabirds were disturbed by seismic surveys using airguns. This conclusion, however, was due in part to natural variation in abundance. Nevertheless, Stemp concluded that negative effects from seismic surveys were not anticipated as long as activities were conducted away from colonies, feeding concentrations, and flightless murres. This implies, however, that conducting these activities near colonies, feeding concentrations, or molting birds could result in negative effects to birds.

Lacroix et al. (2003) investigated the effects of seismic surveys on molting long-tailed ducks in the Beaufort Sea. These ducks molt in and near coastal lagoons on the North Slope, primarily during August, during which time they are flightless for 3-4 weeks. The molt is an energetically costly period. Long-tailed ducks are small sea ducks with higher metabolic rates and lower capacity to store energy than larger ducks (Goudie and Ankney, 1986). Consequently long-tailed ducks need to actively feed during the molt period because their energy reserves cannot sustain them during this period (Flint et al., 2003). Lacroix et al. (2003) stated there was no clear response by the ducks to seismic surveying, even when the seismic vessels were in visual range. However, there may be effects that were too subtle to be detected by this study. The presence of long-tailed ducks within several 2.5-km radii of the sound source was monitored, but it was not possible to determine short-distance movements in response to seismic activities. Diving

behavior of long-tailed ducks also was monitored by radio-telemetry, because direct observations may have induced bias due to the presence of observers. Therefore, it is unclear whether changes in diving frequency were due to disturbance from seismic vessels or local abundance of prey items. For instance, ducks may dive more in response to disturbances from vessels or they may dive less to avoid underwater noises related to airguns. Further behavioral observations would be necessary to characterize the response of long-tailed ducks and other birds to seismic surveys, even though the Lacroix et al. (2003) study found no effect of seismic surveying on movements or diving behavior of long-tailed ducks.

While seismic airguns have the potential to alter the availability of marine bird prey, Vella et al. (2001) concluded that there generally are few behavioral or physiological effects unless the organisms are very close (within meters) to a powerful noise source. Consequently, noises from seismic airguns are not likely to decrease the availability invertebrate crustaceans, bivalves, or mollusks.

It is possible that seismic surveys might affect fish and invertebrates in proximity to the airgun array. However, the effects of seismic surveys on marine fish that might change their availability to marine birds have not been documented under field operating conditions (Canadian Department of Fisheries and Oceans [CDFO] 2004). If forage fishes are displaced by airgun noise, birds feeding on those resources might be temporarily displaced and stop feeding within a few kilometers of the survey activities.

It is possible, during the course of normal feeding or escape behavior that some birds could be near enough to an airgun to be injured by a pulse. The threshold for physiological damage, namely to the auditory system, for marine birds is unknown. Although MMS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. “Ramping-up,” a gradual increase in decibel level as the seismic activities begin, can allow diving birds to hear the start up of the seismic survey and help disperse them before harm occurs. During seismic surveys, diving birds likely would hear the advance of the slow-moving survey vessel and associated airgun operations and move away.

4.4.1.6.2.1.9. Cumulative Effects from Global Forces. Scientific and public interest in the Arctic is at an all time high owing to a multitude of warming-induced changes now under way there and a growing appreciation for the region’s importance to the global climate system. Temperatures over arctic land areas have risen and continue to rise at roughly twice the rate of the rest of the world. The implications of climate change on coastal and marine birds are impossible to predict with any precision, but some trends are evident and are anticipated to continue. This section briefly describes likely ongoing effects on coastal and marine birds from changes in oceanographic processes and sea ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise.

4.4.1.6.2.1.9.1. Changes in Oceanographic Processes and Sea-Ice Distribution. In recent decades, the Arctic has witnessed significant climatic and other environmental changes including notable decreases in the extent of sea ice. The sea ice is thinner, begins melting sooner, forms later, and retreats farther from shore each year. Because of this, and in conjunction with other related factors, it is commonly perceived that the Chukchi Sea is changing to become more like the Bering Sea, and the western Beaufort Sea is changing to become more like the Chukchi Sea.

To understand ongoing changes in the Arctic region it may be helpful to look at similar situations in the Bering Sea. Evidence shows that the Bering Sea is changing (Grebmeier et al., 2006, 2008). Some of these changes probably have benefited Arctic-nesting birds, because some important prey resources likely have increased, especially at critical times in their lifecycle. For example, Springer et al. (1984) concluded that a pattern of climatic cooling in the early 1970s followed by warming in the second half of

the decade caused annual differences in the extent and duration of sea ice, and apparently in the spatial and temporal development of Alaskan Coastal Water, a major oceanographic feature of the Bering-Chukchi shelf. Fluctuations in the physical environment have led to changes in fish populations through direct physiological and behavioral effects, or indirectly by altering the abundance of important zooplankton prey populations (Springer et al., 1984). Variability in the reproductive success of murres and kittiwakes studied at Cape Thompson and Cape Lisburne corresponded with the apparent changes in fish stocks.

On the other hand, prey resources important to other birds in the Chukchi Sea may shift north and become less abundant during important life stages. For example, about 500,000 seabirds from Cape Lisburne to Cape Thompson forage in Ledyard Bay for most of the summer. Similarly, hundreds of thousands of sea ducks reportedly feed on benthic invertebrates in Ledyard Bay during the spring and fall for staging and molting. The total annual removal of biomass from Ledyard Bay must be considerable, yet the processes supporting such sustained productivity are not known. The oceanographic processes affecting Ledyard Bay could be influenced by northward movements of Bering Sea currents and the distribution of sea ice in the spring. Oceanographic processes that have resulted in changes to the productivity in Ledyard Bay have affected nearly a million birds, but effects on bird populations have not been documented or studied.

Mild winters in the Bering Sea may be favoring those species that often contend with harsh environmental conditions there. During mild winters, energy that would have gone to contend with harsh environmental extremes could have been directed towards improving the condition of the female. Lehikoinen, Kilpi, and Ost (2006) demonstrated that common eiders (*Somateria mollissima*) wintering off Finland had greater breeding success following mild winters. In this study, female broodrearing behavior was linked to offspring survival and condition. Female condition was linked to offspring quality in terms of yearly survival. Females could be in poorer condition after a severe winter and would not allocate as much resources to breeding.

Implications for other coastal and marine birds include a continuation of trends observed for several species, most notably birds that typically forage on resources at the ice edge, such as black guillemots and ivory gulls. These species must either make longer forays to the ice edge from their breeding sites or change to alternative prey, two options that likely would result in lowered reproductive performance. Similar changes could occur to those species reliant on the productivity of nearshore waters in the spring, because those productive zones may be lost or displaced (see Section 3.3.1). Birds unable to replenish or build energy stores prior to breeding could experience decreased survival or reproductive success. Decreasing nearshore biotic productivity also could degrade the quality of broodrearing areas.

4.4.1.6.2.1.9.2. Duration of Snow and Ice Cover. Similar to sea ice, seasonal river- and lake-ice cover is breaking up earlier each year, and the open-water season is longer. Lake-dependent species, such as loons or swans, could benefit because their young would have more time to become flight capable.

Thinner snow cover over tundra would melt earlier, allowing Arctic-nesting birds to begin nesting sooner. Arctic-nesting birds have adapted to a narrow range of nest-initiation dates. Birds typically are able to start nesting when sites first come available; they may not be able to raise a brood successfully if nesting is delayed. On the other hand, earlier lay dates observed in black guillemots may provide parents greater access to the ice edge before it recedes away from the nesting colony (Friends of Cooper Island, 2007).

Earlier nesting also could benefit many other species nesting on the tundra if other components of the food chain are on the same phenology. Birds likely are unable to successfully shift their nesting phenology outside of the normal range, if high-value food resources are not available at critical times (i.e., interacting predator-prey species react differently to warming, referred to as “trophic asynchrony”). Shifts to earlier laying dates could result in overall decreased clutch size or chick survival, if nutritional

needs are outside the period of favorable food conditions (Visser, Both, and Lambrechts, 2004). In this case, climate change could lead to mistiming and failure of reproduction, and certain marine and coastal bird populations could decline.

4.4.1.6.2.1.9.3. Distribution of Wetlands and Lakes. Scientific evidence indicates that tundra habitats have changed and will continue to change. Perhaps the most important changes to arctic vegetation are expected in the form of expanding and retreating lakes and wetlands. Much of the ACP is underlain with permafrost. Permafrost close to the surface plays a major role in freshwater systems, because it often maintains lakes and wetlands above an impermeable frost table, which limits the water storage capabilities of the subsurface. Permafrost is warming along with the rest of the Arctic. Scientific models predict that large-scale changes in permafrost are likely, and significant permafrost degradation has been reported in some locations.

As warming continues, some regions of the Arctic will see shifts in permafrost distribution and deepening of the active layer, accompanied by changes in vegetation. The active layer is the topmost layer of permafrost that thaws during the summer, allowing organic processes to occur. As the active layer becomes saturated, it is prone to collapse (mass wasting). Permafrost collapse tends to result in the slumping of the soil surface and flooding, followed by a complete change in vegetation, soil structure, and many other important aspects of these ecosystems. Initially, over an unknown time period, flooding results in a boost of vegetative productivity and the expansion of wetlands and shallow lakes. Over time, however, as the permafrost continues to melt and infiltration increases, shallow summer groundwater tables continue to drop and subsequent drying of wetlands and drainage of lakes occurs.

Recent studies using satellite and field data have revealed remarkable changes in the number and total area of arctic lakes and wetlands in just the past few decades. A preliminary assessment is that they are growing in northern areas of continuous permafrost, but disappearing farther south. Lakes in areas of continuous and discontinuous permafrost have experienced substantial shrinkage, likely due to permafrost degradation allowing them to drain to the subsurface. A study of arctic lakes in Siberia observed that many lakes have disappeared or shrunk in the last 30-40 years (Smith et al., 2005).

The unique character of ponds and lakes is a result of the long frozen period, which affects nutrient status and gas exchange during the cold season and during thaw. Climate warming could change the characteristics of waterbodies that presently freeze to the bottom and can result in fundamental changes in their limnological characteristics. A lengthening of the growing season and warmer water temperature would affect the chemical, mineral, and nutrient status of lakes and most likely have deleterious effects on the food chain (Rouse et al., 2007). Smol and Douglas (2007) reported that not all lakes are disappearing due to degradation of permafrost, but that some lakes have become desiccated as a consequence of increasing evaporation/precipitation ratios, another outcome of climate change.

4.4.1.6.2.1.9.4. Sea Level Rise. Sea level rise is regarded as one of the more certain consequences of global climate change. During the past 100 years, sea level has risen at an average rate of about 1-2 millimeters (mm) per year (or 4-8 inches [in] per century [USGS, 2007; Titus and Narayanan, 1995]). The projected two- to five-fold acceleration of global average sea level rise during the next 100 years will inundate low-lying coastal wetland habitats that cannot move inland or accrete sediment vertically at a rate that equals or exceeds sea level rise.

Coastal wetlands are particularly vulnerable to sea level rise associated with increasing global temperatures. Freshwater systems in the Arctic are dominated by a low-energy environment and cold-region processes. Changing rates and timing of river runoff will alter the temperature, salinity, and oxygen levels of coastal estuaries. Inundation by rising sea levels, intensification of storms, and higher

storm surges threaten coastal estuaries and wetlands. For many of these systems to persist, a continued input of suspended sediment from inflowing streams and rivers is required to allow for soil accretion.

The potential loss of coastal marshes could result in substantial impacts to birds that rely on unique resources provided at these uncommon sites. Johnson (1993), for example, demonstrated that Kasegaluk Lagoon is an important autumn staging area for Pacific Flyway Brant. Brant concentrate in Kasegaluk Lagoon while staging for southward migrations, foraging on abundant aquatic plants, such as *Ulva*. Migrating species will face altered conditions and their traditional food sources will be lost or become available at different times of the year, potentially threatening long-established relationships that are essential to species survival.

4.4.1.6.2.2. Mitigation Measures. The following mitigation measures are in effect to protect ESA-listed and other marine and coastal birds during Federal and State seismic activities and exploration drilling operations in the Chukchi Sea and Beaufort Sea. The Federal measures represent the collective result of recent Section 7 consultations for lease sales (Lease Sales 193, 186, 195, and 202) and programmatic seismic activities in the Chukchi and Beaufort seas.

Seismic Activities:

- No seismic activity, including resupply vessels and other related traffic, will be permitted within the Ledyard Bay spectacled eider critical habitat area following July 1 of each year, unless human health or safety dictates otherwise.
- Seismic-survey support aircraft must avoid overflights across the Ledyard Bay spectacled eider critical habitat area below an altitude of 1,500 ft (450 m) after July 1 of each year, unless human health or safety dictates otherwise. Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters as much as possible. Designating aircraft flight routes will be established for situations when aircraft associated with seismic activity cannot maintain >1,500 ft above sea level (ASL) over the Ledyard Bay Critical Habitat Area.
- Ramping-up procedures will be used when initiating airgun operations.
- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m-bathymetric contour. High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting seismic surveys. However, navigation lights, deck lights, and interior lights could remain on for safety.
- All bird-vessel collisions (with vessels or aircraft) shall be documented and reported within 3 days to MMS. Minimum information will include species, date and time, location, weather, and if a vessel is involved in its operational status when the strike occurred. Bird photographs are not required but would be helpful in verifying species. Operators are advised that FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
- Operators must maintain a minimum spacing of 15 mi between the seismic-source vessels for separate operations.
- Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic-substance spill. If vessels transit through the spring lead system before June 10, they may encounter concentrations of listed eiders. The FWS therefore requires that wildlife hazing equipment (including Breco buoys or similar equipment) be prestaged and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site oil-spill-response vessel, to ensure rapid deployment in the event of a spill.

Spectacled and Steller's eiders could experience direct mortality through collisions with vessels, aircraft, or drilling structures. Specific measures to be implemented that would minimize the potential for adverse

effects to ESA-protected eiders from MMS-authorized activities on existing leases in the Chukchi Sea are (USDOI, MMS, 2007, Final Notice of Sale for Lease Sale 193):

Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller’s Eiders During Exploration Activities. This stipulation will minimize the likelihood that spectacled and Steller’s eiders will strike drilling structures or vessels. The stipulation also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area, during times when eiders are present.

(A) General conditions: The following conditions apply to all exploration activities.

- (1) An EP must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, and aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
- (2) The following conditions apply to operations conducted in support of exploratory and delineation drilling.
 - (a) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least three *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may be located onboard the vessel or on a nearby oil spill response vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.
 - (b) Except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.
 - (c) Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level over the listed blocks or Federal waters between the listed blocks and the coastline between April 15 and June 10, or the Ledyard Bay Critical Habitat Area between July 1 and November 15, to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.

(B) Lighting Protocols. The following lighting requirements apply to activities conducted between April 15 and November 15 of each year.

- (1) **Drilling Structures:** Lessees must adhere to lighting requirements for all exploration or delineation drilling structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive

requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- Types of lights;
- Adjustment of the number and intensity of lights as needed during specific activities;
- Dark paint colors for selected surfaces;
- Low-reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational, and management approaches that could be applied to their specific facilities and operations to reduce outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an EP when it is submitted for regulatory review and approval pursuant to 30 CFR 250.203.

(2) Support Vessels: Surface support vessels will minimize the use of high-intensity work lights, especially when traversing the listed blocks and federal waters between the listed blocks and the coastline. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog); otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.

For the purpose of this stipulation, the listed blocks are as follows:

NR02-06, Chukchi Sea: 6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872

NR03-02, Posey: 6872, 6873, 6918-6923, 6967-6973, 7016-7023, 7063-7073, 7112-7123

NR03-03, Colbert: 6674, 6723, 6724, 6771-6774, 6820-6824, 6869-6874, 6918-6924, 6966-6974, 7015-7024, 7064-7074, 7113-7124

NR03-04, Solivik Island: 6011-6023, 6060-6073, 6109-6122, 6157-6171, 6206-6219, 6255-6268, 6305-6317, 6354-6365, 6403-6414, 6453-6462, 6502-6511, 6552-6560, 6601-6609, 6651-6658, 6701-6707, 6751-6756, 6801-6805, 6851-6854, 6901-6903, 6951, 6952, 7001

NR03-05, Point Lay West: 6014-6024, 6062-6073, 6111-6122, 6160-6171, 6209-6221, 6258-6269, 6307-6317, 6356-6365, 6406-6414, 6455-6462, 6503-6510, 6552-6558, 6602-6606, 6652-6655, 6702, 6703

NR04-01, Hanna Shoal 6223, 6267-6273, 6315-6323, 6363-6373, 6411-6423, 6459-6473, 6507-6523, 6556-6573, 6605-6623, 6654-6671, 6703-6721, 6752-6771, 6801-6819, 6851-6868, 6901-6916, 6951-6964, 7001-7010, 7051-7059, 7101-7107

NR04-02, Barrow: 6003-6022, 6052-6068, 6102-6118, 6151-6164, 6201-6214, 6251-6262, 6301-6312, 6351-6359, 6401-6409, 6451-6456, 6501-6506, 6551, 6552, 6601, 6602

NR04-03, Wainwright: 6002-6006, 6052, 6053

NS04-08, (Unnamed): 6816-6822, 6861-6872, 6910-6922, 6958-6972, 7007-7022, 7055-7072, 7104-7122

Nothing in this stipulation is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

Note: The MMS and FWS have reconsulted under Section 7 of the ESA on a case-by-case basis for exceptions to these mitigation measures. For the 2006-2008 summers, industry has been required by the NMFS to deploy an array of passive acoustic monitoring devices, three stations were within the outer margin of the LBCHA after July 1, as a condition of their Incidental Harassment Authorization under the MMPA. The MMS or NMFS determined, and the FWS concurred, that a maximum number of three trips into and out of the LBCHA under the shortest possible, pre-determined route was not likely to adversely affect threatened eiders. Other industry vessel traffic associated with MMS-authorized activities has been

directed to use nearshore areas not included in the LBCCHA or have used the margin of the LBCCHA in consideration of maritime safety - all consistent with the intent of these mitigation measures.

Mitigation Measures for the existing and anticipated Beaufort Sea Lease Sales on State of Alaska lands specific to protection of bird resources (ADNR 2008) include:

22. Birds:

- a. Permanent, staffed facilities must be sited to the extent feasible and prudent outside identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas.
- b. Due to high concentrations of staging and molting brant and other waterbirds within the coastal habitats along the Teshekpuk Lake Special Area (TLSA) and other areas, operations that create high levels of disturbance, including but not limited to dredging, gravel washing, and boat and barge traffic along the coast, will be prohibited from June 20 to September 15 within one-half mile of coastal salt marshes, specifically In addition, Tracts 228 and 231 are subject to the same restrictions between May 15 and July 30 to protect large concentrations of breeding snow geese. The construction and siting of facilities within one mile of these areas may be allowed on a case-by-case basis if the Director, DO&G and ADF&G determine that no other feasible and prudent location exists.

Similarly, the NSB has passed local ordinances that we assume apply to existing state leases:

- 1a. Lessees shall comply with the Recommended Protection Measures for Spectacled and Steller's Eiders developed by the FWS to ensure adequate protection of spectacled eiders during the nesting and brood rearing periods.
6. Aircraft Restrictions: To protect species that are sensitive to noise or movement, horizontal and vertical buffers will be required, consistent with aircraft, vehicle and vessel operations regulated by NSB Code §19.70.050(I)(1) which codifies NSBCMP policy 2.4.4.(a). Lessees are encouraged to apply the following provisions governing aircraft operations in and near the proposed sale area:
 - a. From June 1 to August 31, aircraft overflights must avoid identified brant, white-fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and from August 15 to September 15, the fall staging areas for geese, tundra swans, and shorebirds, by an altitude of 1,500 feet, or a lateral distance of one mile.

4.4.1.6.2.3. Anticipated Level of Effects Under Alternative 1. This section describes the impact on threatened and endangered birds resulting from the incremental impact of the action (which for this alternative is taking no action) and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions are described in Section 3.1 as they affected threatened and endangered birds. Reasonably foreseeable future actions are described in Section 4.2. The mitigation measures (described in Section 4.4.1.6.2.2) and the following important factors are considered in determining the anticipated effects from this alternative.

Timing. The window of time for exploration typically includes the open-water period. Accordingly, this largely eliminates potential effects during spring migration for marine and coastal birds, unless exploration vessels traverse the spring lead system. Effects still are possible during open-water periods where activities could affect birds that are molting, foraging, and migrating after the breeding season. For production, operations would take place year-round, and effects would be possible from a variety of sources throughout the year.

Residence Time and Periodicity. Effects vary based on whether activity in the area is short-term or long-term and whether it involves passage through an area on a frequent or intermittent basis. During exploration, drill ships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft likely would need to make trips between the drill ship and shore to deliver personnel and equipment. Residence time and periodicity of drill ships and support vessels during exploration could affect molting, foraging, and postbreeding migrant threatened and endangered birds.

Spatial Extent. The lease sale area is large, and the area explored in any given season is small by comparison. Beyond the footprint of a seismic vessel or drill ship, consideration must be given to the area affected by noise, support-vessel traffic, and other secondary factors that could affect birds.

Environmental Factors. Weather, currents, wind, and other environmental variables all influence the intensity or magnitude of potential effects. Limited visibility due to fog, rain, and snow can affect the ability of birds to detect structures and avoid them. Limited visibility, coupled with bright lights, also may attract birds and increase the risk of collisions.

Oil Spills. We recognize that if a large oil spill occurred where there were concentrations of marine and coastal birds, large-scale mortality could occur to some species, representing a major population-level effect. Large spills could arise from a variety of sources, especially during bulk fuel deliveries or other marine accident. A very-large spill from a well blowout is described as a very unlikely event and evaluated in Appendix A, Section 1.1.4.

Extent of mortality that could result from oil spills during oil production (currently viewed as being speculative until a large commercially developable field is discovered) is extremely difficult to estimate. First, it is uncertain that oil would ever be discovered. The potential that a commercial field would be discovered in the Chukchi Sea is $\leq 10\%$ and about 20% in the Beaufort Sea. Secondly, it also is uncertain that oil would be spilled. As stated in the Beaufort Sea Multiple-Sale EIS (USDOJ, MMS, 2003a), the chance of one or more large ($\geq 1,000$ bbl, 42,000 gal) spills occurring during the life of the project (~26 years) was 8-10%. The multiple-sale EIS and the Sale 195 EA explain that the occurrence estimate includes only part of the variability in the Arctic effects on the spill rate. During Fiscal Year 2004, MMS procured the study titled *Improvements in the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas*. The study included the non-Arctic variability of spill frequency and spill size. An implication from this study is that the chance of one or more large spills increased from 8-10% (USDOJ, MMS, 2003a: Section IV.A.4.a (1)) to 21% for Sale 202. The extent of mortality of marine and coastal birds from such a spill will be greatly influenced by the number, volume, trajectory, and timing as well as the period that oil remains in the environment.

Following production, a larger number of small spills (<1,000 bbl) could occur, but most of these would be into containment (not the open ocean), and their size limits spread and persistence due to weathering and other environmental factors. In addition, the low probability of such events, combined with the uncertainty of the location of the spill and the seasonal nature of the bird resources in the area, make it highly unlikely that numerous chronic small spills or a large oil spill would contact large numbers of marine or coastal birds. Many marine and coastal birds are present on the North Slope for only 3-5 months out of the year. Even if birds were present in the vicinity of an oil spill, they might not be contacted by the oil due to avoidance behavior, ice conditions, or weather patterns. For example, 68,000 gal of heating oil were reportedly spilled into the Beaufort Sea near Kaktovik in 1988. No oiled birds or other wildlife were discovered and the USCG closed the case.

Considering the low probability of a large spill, coupled with a variety of other factors that would need to occur simultaneously to result in coastal and marine bird mortality, we anticipate that it is highly unlikely that major impacts will result from oil spills associated with OCS oil and gas activities within the Chukchi Sea or Beaufort Sea lease-sale areas. The MMS requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment. For the purposes of the following analyses, numerous small spills or large spills from OCS oil and gas activities are considered high effect, low likelihood events and are not considered reasonably foreseeable.

For the same reason, it is difficult to estimate the potential for chronic small spills or a large spill to originate from private, commercial, or State sources within the Chukchi or Beaufort seas. Increasing vessel traffic (in general) and bulk fuel deliveries (in particular) appear to present an obvious danger to threatened and endangered birds in the Arctic.

Effects Definitions and Levels. We used the terms negligible, minor, moderate, and major to describe the relative degree or anticipated level of effect of an action on birds. Following each term below are the general characteristics we used to determine the anticipated level of effect. For all terms, best professional judgment was used to estimate population size when current or precise numbers were not known.

Negligible: Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across 1 year. No mortality is anticipated. Mitigation measures implemented fully and effectively or not necessary.

Minor: Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year or localized effects that are anticipated to persist for more than 1 year. Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local postbreeding population. Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate: Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year, but less than a decade. Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect. Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities would likely be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major: Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer. Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect. Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are widespread and long-lasting.

The following conclusions are separated into the direct and indirect effects (Section 4.4.1.6.2.3.1) and the cumulative effects (Section 4.4.1.6.2.3.2) of implementing this alternative. As threatened and endangered birds represent a resource group, we address differential effects to specific species in Section 4.4.1.6.2.4.

4.4.1.6.2.3.1. Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts to ESA-listed birds in the project area from not holding Lease Sales 209 or 217. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.6.2.3.2. Cumulative Effects Under Alternative 1.

Summary. Marine and coastal areas of the North Slope are commonly perceived to be a pristine environment, yet there are a number of past and existing sources of harm, an increasing number of threats, and anticipated environmental changes, that will negatively affect spectacled and Steller's eiders and Kittlitz's murrelets in the project area well into the future, even if none of the proposed lease sales are held.

Primary considerations include:

- The most important impacts to Steller's and spectacled eiders and Kittlitz's murrelets likely will arise from continued climate change and the loss or expansion of habitats important to these birds, any changes in breeding chronology or trophic asynchrony. As these species are already imperiled, an inability to adapt to a changing environment could negatively affect their distribution or abundance.
- Uncontrolled vessel and aircraft disturbance could continue to harm ESA-listed birds in nearshore broodrearing or molting areas. It is unclear if these impacts accumulate year to year, but chronic stress during sensitive life stages, especially the molt, likely would lead to long-term changes in survival and productivity.
- Collisions with existing structures (production facilities on State lands, power lines, communication towers, etc.) in coastal areas could continue at a low rate. Preventive measures were not required for most structures, and special lighting protocols likely would not be implemented on existing developments. New development presents sources of collision hazard, if preventive measures are not taken. Collision mortality, however, does not appear to be a significant source of mortality; however, there is little monitoring for collision mortality.
- Bird predator species, especially foxes and ravens, are anticipated to continue to expand in distribution and abundance due to a lack of effective control over access to human-use foods or garbage and an increasing abundance of nesting or denning sites. The adverse effect these predators have on ESA-listed bird populations is not clearly understood and is partially offset by small mammal-population cycles; however, the relationship appears to be out of natural ecological balance and will only continue to negatively affect ESA-listed bird populations without concerted management action.
- Spills, particularly in offshore areas, pose the greatest threat to birds in marine areas. Existing and anticipated future increases in vessel traffic, especially from tourism or shipping, could increase the chance of a marine accident. Barring these events, deliveries of bulk fuel to coastal communities pose the greatest chance of a large noncrude oil spill in the marine environment.
- Climate-related changes will continue to occur to bird habitats along the Beaufort Sea, perhaps to a greater extent than all other anticipated effects combined.

While many of these negative influences are difficult or impossible to control, increased attention to minimizing these effects could reduce anthropogenic sources of stress or mortality to listed eiders. As it remains unclear what factor(s) is most affecting eider populations, changes in eider populations are difficult to predict. We anticipate that existing trends would continue, and ESA-listed eider populations would stabilize. While little information exists for the Kittlitz's murrelet in the Chukchi Sea, recent surveys indicated a surprising abundance of postbreeding Kittlitz's murrelets immediately west of Barrow (Renner et al., 2008). Additional surveys are needed to verify if there is consistent use of this area by Kittlitz's murrelets.

4.4.1.6.2.3.2.1. Anticipated Level of Effect from Vessel Presence and Noise. Section 3.1.3.2 describes the general past and present vessel-traffic patterns in the Beaufort Sea. Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research vessels in the Arctic, such as those seeking to explore and study Arctic regions via the Northwest Passage. We anticipate this trend to continue into the reasonably foreseeable future. These vessels are free to navigate open waters where they could encounter and disturb Steller's and spectacled eiders. For example, traffic between the Beaufort Sea and the Bering Sea could pass through areas seasonally important to spectacled eiders, such as the Ledyard Bay Critical Habitat Area.

There is a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific Ocean and the Atlantic Ocean. Increasing military activities also are anticipated. As with tourism and research traffic, both commercial and military large-vessel traffic could disturb large numbers of ESA-protected birds. Uncontrolled vessel disturbance from anticipated tourism, research, shipping, and military vessels could result in chronic, long-term disturbances to ESA-listed birds.

Oil and gas exploration and development in near-shore waters under state jurisdiction could add to disturbance potential experienced by Steller's and spectacled eiders in the Beaufort and Chukchi Sea regions, however there may be mechanisms via the state permitting process to implement mitigation measures to reduce vessel impacts to ESA-listed birds in the Beaufort Sea.

Mitigation measures required on future exploration and development activities on existing leases or surrounding waters avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While these actions likely would result in an incremental increase in the total number of vessels operating in the Beaufort Sea, these vessels would have proportionately fewer impacts compared to other unrestricted vessels operating in this area.

Summary. Vessel presence and noise under Alternative 1 are anticipated to result in a continued minor level of effect on threatened and endangered birds.

4.4.1.6.2.3.2.2. Anticipated Level of Effect from Aircraft Presence and Noise. Aircraft traffic could adversely affect listed birds by: (1) displacing adults and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. The behavioral response of eiders to low-level aircraft flights is unknown; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate frequent aircraft noise. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport. Some birds may be displaced, with unknown physiological and reproductive consequences.

Disturbance to nesting spectacled and Steller's eiders probably is limited due to their extremely low densities across the North Slope. Across the ACP of the North Slope, breeding-season density averages approximately one pair per 8 km² for spectacled eiders (Larned et al., 2003). Steller's eiders are so rare in some years that they are not detected at all by aerial-survey methods. In the core of the Steller's eider breeding area near Barrow, the highest nesting density recorded during 4 years of aerial surveys was estimated as approximately one pair per 12.5 km² (Ritchie and King, 2002). Densities elsewhere on the ACP are much lower.

Most aircraft on the North Slope are operated without altitude or route restrictions to protect threatened or endangered birds. Some traffic associated with State oil and gas operations is restricted to protect certain

species that may also benefit ESA-listed birds (ADNR, 2008). Frequent low-level flights associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact birds, but at an unknown level. Any adverse effects are anticipated to continue.

The number of nesting Steller's or spectacled eiders that would be exposed to low-level flights associated with OCS oil and gas development on existing leases or surrounding waters is low, because the potential direct flight from an airbase to offshore drilling sites within the OCS primarily would be over coastal waters. Mitigation measures imposed on future exploration and development activities avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of flights, these flights would have proportionately fewer impacts compared to other aircraft operating in the project area.

Summary. Aircraft presence and noise under Alternative 1 are anticipated to result in a continued minor level of effect on threatened and endangered birds.

4.4.1.6.2.3.2.3. Anticipated Level of Effect from Collisions. The ESA-protected birds will continue to strike structures during periods of darkness or inclement weather in nearshore areas. Some facilities are lit in such a manner that may attract and disorient flying birds, resulting in unavoidable impacts. If improvements to lighting were made these impacts could become avoidable. The location of the project is a primary determinant whether some risk of collisions exists. For example, the NSB has proposed to reconstruct/relocate the existing airport on Barter Island. This airport services Kaktovik. The project proposes to run a power line to the new sites, which could increase the number of migratory birds killed. As the site is outside the typical distribution of ESA-listed eiders, few impacts to eiders from collisions would be expected.

Monitoring of bird-strike mortality across the North Slope is infrequent, so the level of mortality cannot be estimated. The FWS maintains a database of reported collisions (USDOI, FWS, 2008). The MMS review of this database indicates the level of mortality to ESA-protected birds appears low, having minor effects on listed eiders.

Oil and gas development in nearshore waters under State jurisdiction could add to collision potential experienced by Steller's and spectacled eiders in the Beaufort Sea region.

While there likely would be an incremental increase in the total number of structures, these structures would have proportionately fewer impacts compared to other structures in the project area. Mitigation measures required on future exploration and development activities on existing leases or surrounding waters are believed to minimize collision mortality to ESA-listed birds in the Beaufort Sea. For example, the Liberty project engineers consulted with MMS and FWS about lighting of the production facility and will implement measures intended to minimize effects on migrating eiders, including the installation of special lights on their sheeppile bulkhead (USDOI, MMS, 2007a).

The MMS and FWS both acknowledge that estimating incidental take of listed eiders is extremely difficult due to a lack of available information. An estimated incidental take of listed species was calculated in the Biological Opinion for the Beaufort Sea Lease Sale 186 (USDOI, FWS, 2002). Collisions with preproduction structures on existing leases in the Beaufort Sea OCS were calculated to result in an incidental take of five spectacled eiders and one Steller's eider (USDOI, MMS, 2003a). While MMS does not assume that recommendations for the design and implementation of lighting of structures would result in no strikes by threatened eiders, both MMS and FWS believe that the lighting protocols will reduce the potential for bird strikes.

Although production from existing Beaufort Sea leases is speculative, we assume that production will occur for analysis purposes. We calculated that as many as 21 spectacled eiders (calculated as = 0.40 [spectacled eider-strike rate] x 26 years [life of production] x 2 [maximum number of platforms]) and one Steller's eider (calculated as = 0.02 [Steller's eider-strike rate] x 26 years [life of production] x 2 [maximum number of platforms]) would occur from collisions with structures associated with production drilling on existing leases in the Beaufort Sea OCS.

The MMS cannot assume that recommendations for the design and implementation of lighting of structures would result in no strikes by threatened eiders. The MMS and FWS both acknowledge that estimating incidental take of listed eiders is extremely difficult due to a lack of available information. An estimated incidental take of listed species was calculated in the Biological Opinion for the Beaufort Sea Lease Sale 186 (USDOI, FWS, 2002). Collisions with preproduction structures on existing leases in the Beaufort Sea OCS were calculated to result in an incidental take of five spectacled eiders and one Steller's eider (USDOI, MMS, 2003a).

Although production from existing Beaufort Sea leases is speculative, we calculated that as many as 21 spectacled eiders (calculated as = 0.40 [spectacled eider-strike rate] x 26 years [life of production] x 2 [maximum number of platforms]) and one Steller's eider (calculated as = 0.02 [Steller's eider-strike rate] x 26 years [life of production] x 2 [maximum number of platforms]) would occur from collisions with structures associated with production drilling on existing leases in the Beaufort Sea OCS.

Summary. Bird collisions resulting from Alternative 1 are anticipated to result in a continued minor level of effect on threatened and endangered birds.

4.4.1.6.2.3.2.4. Anticipated Level of Effect from Petroleum Spills. The potential effects of spills on birds were described in Section 4.4.1.6.2.1.4 and factors in Section 4.4.1.6.2.3.2. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of birds. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during period of ice are more prone to an accident. The ADEC (2007) reports that the highest probability of spills of noncrude products occurs during fuel transfer operations at the remote villages of the North Slope.

Other sources of petroleum spills include a well blowout or other oil spills/toxics contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea, but these are modeled as having a low percent chance of occurring, and it is improbable that adverse effects to ESA-protected birds from these activities would occur. A very-large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4.

The potential for spills to contact ESA-protected species is best summarized in the Biological Opinion prepared by the FWS for the Beaufort Sea Oil and Gas Lease Sales 186, 195, and 202 Final EIS (USDOI, MMS 2003a:Appendix C):

If a large oil spill occurred in the location of and during spectacled eider presence, spectacled eider mortality would be < individuals; however any substantial loss (25+ individuals) would represent a significant effect (MMS Lease Sale 186). It is unlikely that take of Steller's eiders will result from a large oil spill in late spring or in early summer unless atmospheric and

oceanic conditions were such that spilled oil dispersed towards Barrow and into the Chukchi Sea. The MMS Lease Sale 186 Oil-Spill-Risk-Analysis modeling runs predict the probability of such a spill scenario to be very low.

Extent of take that will result from oil spills from the proposed action is extremely difficult to estimate. First, it is uncertain that oil will be spilled. As stated in the biological evaluation, the likelihood of at least one spill of at least 1,000 bbl (42,000 gal) during the life of the project (~26 years) is currently estimated to be 8-10%. In the unlikely event of such an oil spill, the extent of take will be greatly influenced by the number, volume, trajectory, and timing of spills as well as the period that oil remains in the environment. In addition, the low probability of such an event, combined with the uncertainty of the location of the spill, and the seasonal nature of the resources inhabiting the area, make it highly unlikely that a large oil spill would contact a threatened eider. Spectacled and Steller's eiders are present on the North Slope for only 3-5 months out of the year. Even if an eider were present in the vicinity of an oil spill, it might not be contacted by the oil due to avoidance behavior, ice conditions or weather patterns. Furthermore, the MMS requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment. Therefore, the probability of a large oil spill contacting a Steller's or spectacled eider is much < 8-10% over the 30 -year life of the proposed leases (2003-2033).

Considering the low probability of a large spill coupled with a variety of other factors that would need to be satisfied to result in take, the Service anticipates that it is highly unlikely that incidental take of listed eiders will result from oil spills within the Lease Sale 186 area. However, should any oil spill within the Lease Sale 186 area result in the take of any Steller's or spectacled eider, the MMS will immediately cease all operations responsible for the take pending reinitiation.

Summary. This alternative is anticipated to result in a negligible level of effect on threatened and endangered birds, because petroleum spills are considered infrequent, illegal, or accidental events.

4.4.1.6.2.3.2.5. Anticipated Level of Effect from Increased Bird Predator Populations. The dependence of ravens on human-use foods and garbage, combined with the potential increase in nesting sites from existing and future developments, are anticipated to continue and will result in the expansion in the distribution and abundance westward across the North Slope. Only a concerted management program to deny ravens access to artificial food sources and removal of nests or ravens would halt the facilitated expansion of breeding ravens across the North Slope. This is not anticipated to occur in the reasonably foreseeable future, and moderate adverse effects to ESA-listed birds are anticipated to continue.

A similar, but lesser, impact occurs from foxes obtaining human-use foods/garbage or denning in sites made suitable from development. While foxes are endemic to the North Slope, densities may be greater due to increased availability of food or den sites.

Mitigation measures imposed on future exploration and development activities on existing leases or surrounding waters would avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of structures or facilities that could be used by bird predators such as ravens or foxes, these facilities would not be constructed or operated in a manner that would support bird predators.

A lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) recently has been implemented for the Liberty project and is anticipated to be implemented

for future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the OCS. For this reason, no incidental take of eiders from increased predator populations is anticipated to occur.

Summary. Alternative 1 is anticipated to result in a continued minor level of effect on threatened and endangered birds.

4.4.1.6.2.3.2.6. Anticipated Level of Effect from Subsistence-Hunting Activity. The FWS has made an effort to educate the local hunting public about the plight of spectacled and Steller's eiders and has stated that the prohibition against harvest of these species would be enforced, but some level of (accidental) harvest may be continuing. It is unknown what that level of harvest is. Improved access can increase the range of hunters to areas where ESA-listed eiders could be misidentified and be killed.

For example, the NSB has proposed to improve or relocate the existing airport on Barter Island. This airport services Kaktovik. One alternative would construct a 5.4 mi road to a new airport on the mainland. The community has favored this alternative for a number of reasons, including increased access to hunting areas (Hattenberg, Dilley, and Linnell, 2008). Another alternative would add a new road south to a new landfill site. Kaktovik is at the extreme limit of ESA-listed eiders; accidental harvest of ESA-listed eiders should not occur, because they seldom occur there.

There would not be any change in subsistence-hunting activity due to exploration activities on existing leases or surrounding waters. Future production of oil or gas resources on the Beaufort Sea OCS remains speculative (Section 4.4.1.6.2.3.2.4). If development and production were to occur, we assume that a pipeline would carry products to pre-existing infrastructure for transport to processing facilities. The pipeline would need a road for periodic maintenance, and this road could increase access of local hunters to previously inaccessible areas. Waterfowl hunters may be able to access pipeline roads during the period immediately following spring breakup to hunt geese and eiders.

It is unknown whether increased access would result in an increased accidental or illegal harvest of spectacled or Steller's eiders following the creation of a road along a pipeline. The long-term consequences of this speculative development would be evaluated in future NEPA documents and via formal consultation under the ESA, but at the present time were not anticipated to result in an incidental take of listed eiders.

Summary. Alternative 1 is anticipated to result in a continued minor level of effect on threatened and endangered birds, because it is reasonable to assume some accidental hunting mortality of ESA-listed birds likely occurs annually.

4.4.1.6.2.3.2.7. Anticipated Level of Effect from Habitat Loss. Existing human development in coastal areas of the Chukchi and Beaufort seas is relatively sparse and limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Development likely will occur in the future, and a corresponding amount of eider nesting habitat will be lost. For example, the Arctic Slope Native Association applied for a Section 404 permit to place gravel fill in about 10 acres of wetlands at Barrow (U.S. Army Corps of Engineers, 2007). Similarly, the State of Alaska is managing a project to fill another 19 acres of wetland habitats to expand the Barrow Airport (U.S. Army Corps of Engineers, 2006). Secondary effects from the zone of influence around new or expanded developments also would result in habitat loss for ESA-listed eiders.

The closest industrial development of size southwest of the proposed lease areas is the Red Dog Mine Portsite near Kivalina, and existing industrial developments (Kuparuk and Prudhoe Bay fields) are east of Teshekpuk Lake (Section 3.1). Continued development likely will occur in and around these sites, and a corresponding amount of eider nesting habitat will be lost. Secondary effects from the zone of influence around new or expanded developments also would result in habitat loss. For example, in April 2008, BPXA applied to the U.S. Army Corps of Engineers for Section 404 permits to fill over 28 acres of wetlands “to support placement of infrastructure for oil and gas development” or similar project (U.S. Army Corps of Engineers, 2008). Secondary impacts to nesting birds could be smaller due to existing developments nearby. The project sites are within the range of ESA-listed eiders.

Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future loss of Steller’s and spectacled eider habitat in the Beaufort Sea region, but certain aspects of these actions would require Federal permits that would require Section 7 consultation under the ESA, which likely would result in minimizing adverse effects of habitat loss.

There would not be any permanent loss or alteration of bird habitat during exploration and delineation activities on existing leases or surrounding waters. Small amounts of temporary habitat loss of Steller’s and spectacled eider migration habitats could occur from drilling exploration or delineation wells into the seafloor.

Future production of oil or gas resources on the Beaufort Sea OCS remains speculative (Section 4.4.1.6.2.3.2.4). If development and production were to occur, facilities would be constructed to extract and transport product to existing processing facilities. Permanent habitat loss could occur if production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas used by Steller’s and spectacled eiders. Indirect habitat losses could result from eiders and murrelets not using habitats near sites of industrial activity.

Postbreeding spectacled eiders molt and replenish/build energy reserves in preparation for migration to the wintering area and winter survival in the Bering Sea. Biologists concur that eiders must make use of high-energy foods to support these physiologically demanding activities. The loss of seafloor habitats due to exploration or delineation drilling cannot be quantified at this time but could be in important molt migration or staging areas. Staging areas for Steller’s and spectacled eiders have not been clearly identified but could be widespread across offshore areas. The importance of these areas relative to the timing of molt, survival during the molting period, and condition after molting is unknown; however, the availability and quality of key resources in those areas during the prolonged migration period ultimately may influence the survival of the spectacled eiders (Petersen, Larned, and Douglas, 1999). No critical habitat for ESA-protected birds has been designated in the Beaufort Sea.

Direct impacts to spectacled and Steller’s eider nesting habitats arise from the facility footprint. We can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but it can be estimated. Onshore developments would originate at a pipeline landfall, the location of which is unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure. Additional airstrip construction or use of overland ice roads/pads is not anticipated.

As a pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-m-wide (65-ft-wide) road, the pipeline “footprint” was integrated with the road footprint into a 0.03 km-wide (100-ft-wide) road/pipeline development “corridor.” The road/pipeline corridor was assumed to be 80 km (50 mi) long. Consequently, direct impacts from pipeline/road construction are estimated to affect 2.45 km² (606 acres) of eider nesting habitat (Table 4.4.1.6.2-1).

The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km² (50 acres) on eider nesting habitat. As many as two pump stations would be needed to move oil, and these stations are estimated to each have a gravel footprint of 0.16 km² (40 acres).

Material to construct the road, shore base, and other facilities would likely come from upland gravel pits, if practicable, or from coastal areas (intertidal areas, barrier islands, etc.) if no feasible and prudent noncoastal alternative is available. The locations of gravel sources near a future alignment are unknown; however, there is some potential that some known gravel sources (identified in USDOI, BLM and MMS, 2003, presently undeveloped) or existing gravel pits would be used/expanded for material-construct fill for the development facilities. For purposes of analysis, we estimated that 0.40 km² of eider nesting habitat would be affected by gravel extraction. Overall, these developments are estimated to have a footprint of 3.41 km² (845 acres) in eider nesting habitats, resulting in an estimated take of four spectacled eiders and one Steller's eider (Table 4.4.1.6.2-1).

Many long-term disturbing activities could have fewer impacts to spectacled and Steller's eiders if they were to occur during winter, when eiders are not present. Material-extraction activities were assumed to occur during winter, when eiders would not be present, and a secondary zone of influence from these areas was considered not applicable.

Secondary or indirect effects to nesting eiders would arise from habitat modifications (drainage, flooding, dust impacts to vegetation, changes in thermokarst) and disturbances from traffic and human activities. The rationale for these calculations and the biological basis for a "zone of influence" are detailed in those biological assessments and resultant biological opinions and are not repeated here. As with previous calculations, our calculations used a zone of influence away from developments measuring 200 m (656 ft). Our calculations did not take into account the amount of overlap in the secondary effects zone that would occur where certain facilities meet. Overall, these zones of influence associated with development facilities have a collective areal extent of 33 km² (8,327 acres) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders and two Steller's eiders (Table 4.4.1.6.2-1).

Summary. Alternative 1 is anticipated to result in a continued minor level of effect on threatened and endangered bird habitats because of annual destruction of eider habitats for community and other industrial development.

4.4.1.6.2.3.2.8. Anticipated Level of Effect from Seismic-Airgun Noise. Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is done during the winter when ESA-protected birds are absent. Offshore surveys on submerged State and Federal lands are conducted by vessels during the open-water period.

The State of Alaska is considering leasing additional State-owned tide- and submerged lands lying between the Canadian border and Point Barrow. Oil and gas development in nearshore waters under State jurisdiction could add to seismic disturbance experienced by Steller's and spectacled eiders in the Beaufort Sea region. Important mitigation measures that likely would be imposed to protect ESA-listed birds are listed in Section 4.4.1.6.2.2.

There are existing Federal leases in the OCS lands of the Chukchi and Beaufort seas, and it is reasonable to expect leaseholders and others to investigate the potential for oil or gas production in the future. Shell Offshore, Inc., for example, likely will continue to complete seismic surveys and well cellars in advance of exploration drilling on certain existing Beaufort Sea leases (USDOI, MMS 2007b). Similar seismic activities are anticipated for other planned development, such as the Liberty Project (USDOI, MMS, 2007c). Additional seismic or exploration work likely would be proposed in the future for other existing

leases in the Beaufort Sea. Exploratory/delineation drilling, seismic work, and related support activities generally would occur primarily during the ice-free, open-water period.

Benthic habitats in used by birds could be disturbed temporarily and/or altered by drilling exploratory or delineation wells in the seafloor. These well-site areas would be small and would be expected to return to predrill condition in fewer than 3 years.

While there likely would be a continuation of existing levels of seismic activity and increased exploration drilling in the Beaufort Sea, mitigation measures would be required on future exploration and development activities to avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea.

Summary. Seismic activity under Alternative 1 is anticipated to result in a negligible level of effect on threatened and endangered birds.

4.4.1.6.2.3.2.9. Anticipated Level of Effect from Changes in the Physical Environment.

Section 4.4.1.6.2.1.9 briefly described likely ongoing effects from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. These changes in the physical environment may affect marine and coastal bird populations, including species protected by the ESA.

Some of these expected changes could benefit coastal birds using habitats on the ACP, at least initially. An expansion of more productive wetland habitats could provide additional nesting sites for several species and boost the abundance and distribution of aquatic plants and insects important to many bird species. These benefits to birds would be expected to decline over time as the wetlands and lakes disappear. The exact timeframes for these changes are not determined and likely vary across the North Slope.

Climatic change could have stochastic or habitat effects on many species that may surpass the impacts of other activities. As previously stated, however, the implications of climate change on threatened and endangered birds are impossible to predict with any precision. For purposes of analysis, we assume most of the obvious trends are anticipated to continue. We consider these trends in determining the effects of the alternatives.

Changes in the physical environment are believed to result from climate changes superimposed on the vagaries of regional weather patterns. These long-term trends are outside the influence of the authorized actions.

Summary. Continued climate change is anticipated to result in a major level of effect on threatened and endangered birds.

4.4.1.6.2.4. Species-Specific Level of Effects. The following analysis describes what anticipated effects would occur in the future, if MMS does not hold any future lease sales in the Beaufort or Chukchi seas. As there would be no other effects from this alternative in the project area, the anticipated effects from the reasonably foreseeable and speculative future activities (Section 4.2) in this case, are the cumulative effects for this alternative.

4.4.1.6.2.4.1. Cumulative Level of Effect to the Steller's Eider. Wetland fills from community and industry infrastructure development immediately could eliminate Steller's eider habitat, compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites could continue to present a collision hazard, and small

numbers of Steller's eiders are expected to be killed. Unrestricted vessel and low-level aircraft traffic could continue to be a chronic source of disturbance.

Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities would be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders. Exploration and delineation drilling activities present a risk that Steller's eiders would collide with a drill ship or other drilling structure. Despite mitigation measures to reduce the risk of this occurring, an incidental take of one Steller's eider was calculated by collision with drilling structures during exploration and delineation activities associated with existing leases in the Beaufort Sea (USDOJ, MMS, 2003a).

The overall effects of potential production (considered speculative) include periodic interruption of postbreeding Steller's eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders to nest outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.41 km² (845 acres) in eider nesting habitats, resulting in an estimated indirect take of two Steller's eiders (Table 4.4.1.6.2-1). We calculated a take of just over one (1.04) Steller's eider would occur from collisions with structures associated with production from existing leases in the Beaufort Sea OCS.

The MMS considers the level of incidental take during exploration activities to be an unavoidable but a minor level of effect to Steller's eiders. No population-level of effect to Steller's eiders is anticipated.

4.4.1.6.2.4.2. Cumulative Level of Effect to the Spectacled Eider. Wetland fills from community and industry infrastructure development immediately could eliminate spectacled eider habitat, compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites would continue to present a collision hazard, and small numbers of Steller's eiders are expected to be killed. Unrestricted vessel and low-level aircraft traffic could continue to be a chronic source of disturbance.

Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities could be achieved, because vessels and aircraft associated with these activities are expected to be managed to avoid conflicts with eiders. For example, vessels would not disturb molting eiders because they would not be permitted in the Ledyard Bay Critical Habitat Area after July 1 of each year, even if they were transiting to the Beaufort Sea.

Exploration and delineation activities present a risk that spectacled eiders would collide with a vessel or drilling structure or be struck by an aircraft. Despite mitigation measures to reduce the risk of this occurring, an incidental take of five spectacled eiders was calculated to be killed by collision with drilling structures during exploration and delineation activities associated with existing leases in the Beaufort Sea (USDOJ, MMS, 2003a).

The overall effects of potential production (considered speculative) include periodic interruption of postbreeding and molting spectacled eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders to be nesting outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.41 km² (845 acres) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders (Table 4.4.1.6.2-1). We calculated that as many as 21 spectacled eiders

would be killed from collisions with structures associated with production from existing leases in the Beaufort Sea OCS.

The MMS considers the level of incidental take during exploration activities to be an unavoidable but a minor level of effect to spectacled eiders. No population-level of effect to the spectacled eider is anticipated.

4.4.1.6.2.4.3. Cumulative Level of Effect to the Kittlitz’s Murrelet. The Kittlitz’s murrelet has not been documented to occur in the Beaufort Sea, but large numbers have recently been reported just west of Barrow and it appears reasonable that some may occur east of Barrow. If some Kittlitz’s murrelets occurred in the Beaufort Sea, they periodically could be disturbed when foraging. Most mitigation or conservation measures that benefit threatened eiders also benefit murrelets. Should production occur, chronic low-volume spills or a large platform or pipeline spill could result in the death of some Kittlitz’s murrelets, but the number affected depends on the time and location of the spills.

Alternative 1 is anticipated to have a negligible level of effect on any Kittlitz’s murrelets in the Beaufort Sea.

4.4.1.6.3. Polar Bear.

In the following analysis, we describe the potential effects to the polar bear from a variety of existing sources without mitigation (Section 4.4.1.6.3.1). We then describe mitigation measures that would avoid or minimize some of these impacts (Section 4.4.1.6.3.2). The anticipated effects are the effects on polar bears of this alternative with mitigation in place (Section 4.4.1.6.3.3).

4.4.1.6.3.1. Potential Effects to Polar Bears. The principal anthropogenic sources of potential adverse effects to polar bears in the Beaufort and Chukchi seas include:

- vessel presence and noise,
- motorized vehicle presence and noise
- subsistence and other harvest
- petroleum spills
- habitat loss and degradation
- seismic noise; and
- changes in the physical environment.

This section addresses potential effects to the polar bear, a species recently listed as threatened throughout its range under the ESA. Polar bears also are protected under the MMPA. In this section, we refer primarily to the Southern Beaufort Sea (SBS) population of polar bears. For a more thorough discussion of the Chukchi Sea (CS) population, see the Chukchi Sea Lease Sale alternatives (Section 4.5). It is important to note that there is a substantial area of overlap between the two populations, and activities in the western Beaufort Sea and the northern Chukchi Sea would have the potential to impact both populations.

The following terms are used throughout this analysis of impacts: negligible, minor, moderate, and major. For purposes of this analysis, these terms are defined as follows. Negligible impacts include localized short-term disturbances or habitat effects that are not expected to continue across multiple seasons. No mortality or impacts to reproductive success or recruitment are anticipated. Mitigation measures are implemented fully and effectively or are not necessary.

Minor impacts include localized chronic disturbances; wide spread short term disturbances; and habitat effects that may persist over time, but are localized to a small area. No adult mortality is expected, though some short term impacts to a few individuals' reproductive success or to recruitment may occur. Mitigation measures are implemented when feasible, but are not feasible for some impacting activities, or some adverse effects are unavoidable. Those adverse effects that are unavoidable are short-term and localized.

Moderate impacts are defined as impacts that are widespread and that may effect more than a few individuals, such as chronic disturbances at key locations or habitat effects that persist for multiple years. Direct mortality of a few individuals may occur; or direct mortality is not anticipated, but ongoing disruption to behavior patterns or important habitat may have high energetic or reproductive or recruitment costs that have the potential to negatively effect the population over time. A single event could result in moderate impacts depending upon the magnitude and specific characteristics of the event. Widespread implementation of mitigation measures for similar activities would likely be effective in reducing the level of unavoidable adverse effects. Unmitigable or unavoidable adverse effects are short-term but widespread; or are long term and localized.

Major impacts include widespread annual or chronic disturbance, habitat effects experienced during one season that would be anticipated to persist for decades, or widespread effects to reproductive success or recruitment. Anticipated or potential mortality could produce a population-level effect. A single event could result in major impacts, depending upon the magnitude and specific characteristics of the event. Widespread implementation of mitigation measures could be effective in reducing the level of avoidable adverse effects. Unmitigable or unavoidable adverse effects are widespread and long-lasting.

4.4.1.6.3.1.1. Potential Effects from Vessel Presence and Noise. Vessel traffic in the Alaskan Arctic generally occurs within 20 km of the coastline and usually is associated with localized fishing and hunting, supply ships, and barges serving local villages or the oil industry. Less frequently, cruise ships, icebreakers, USCG operations, and scientific research vessels operate in the Beaufort Sea. With the exception of an occasional icebreaker, traffic at present is limited primarily to summer and early autumn. Polar bears may be stressed by energy expenditures related to avoiding ships or traffic in the lead systems. However, encounters are less likely to occur in open water. Polar bears may be temporarily drawn to or displaced by icebreaker traffic (Brueggeman et al., 1991). In addition, icebreaker activity may alter habitat used by polar bears.

4.4.1.6.3.1.2. Potential Effects from Motorized Vehicle Presence and Noise. Sources of flights and motorized travel on the North Slope include local transit from village to village, subsistence activities, industry activities, scientific research, and some guiding and tourism. Polar bears may be displaced temporarily by aircraft or may expend energy reserves avoiding aircraft. Polar bears also may be displaced or disturbed by ground transportation, such as snow machines, heavy industrial vehicles, or rolligons. On average, polar bears react to avoid snowmobiles at a distance of approximately 1 km and may be displaced by as much as 3 km. Females with cubs react at greater distances and with more intense and persistent responses, thus expending more energy, than adult males or lone adult females. Polar bears may take flight to avoid snow machines before having been detected by the rider (Andersen and Aars, 2008). Although it is very difficult to assess cumulative population-level effects from short-term disturbance of individual animals, bears that already are nutritionally stressed may be impacted by repeated disturbances over time (Evans, 2008, pers. commun.). In addition, polar bears are vulnerable to heat stress (Best, 1982; Stirling, 1988), and they may become overheated if forced to run to evade vehicles in warm weather. Impacts, if any, are likely to occur nearshore, as very little motorized vehicle or airplane traffic takes place more than 20 km offshore.

Polar bears commonly den along the northeastern coast of the Beaufort Sea in Alaska. Denning polar bears are more sensitive to disturbance in the fall, but the energetic costs of disturbance may be higher in the spring. Polar bear cubs forced to leave dens early due to anthropogenic disturbances are at increased risk of predation and mortality from other causes. There is some evidence that some bears may habituate to noise. Smith et al. (2007) found that polar bears using dens between 1 and 2 km from ice roads were less vigilant than polar bears not exposed to industry activities, indicating that the bears may have become acclimatized to the activity and no longer perceived it as a risk (Smith et al., 2007; Amstrup, 1993). In other instances, polar bears have abandoned dens due to human activities in the vicinity (Perham, 2008, pers. commun.).

4.4.1.6.3.1.3. Potential Effects from Subsistence and Other Harvests. The SBS stock is harvested by both Alaskan Native and Canadian hunters. On average, 32 bears from the SBS stock are taken annually in Alaska (Angliss and Outlaw, 2005). Current harvest rates of the SBS stock are below the harvest quota of 40 animals. As stocks increase or decline, harvest quotas are adjusted through an agreement between the Inuvialuit Game Council and the NSB (see Section 4.4.1.12).

Polar bears occasionally are taken in defense of life and property (DLP) near villages and potentially at industry sites. Two polar bears have been killed as DLP takes in association with industry and military activities, one in 1990 at the Stinson Oil Exploration site, and the other in 1993 at the Oliktok Point Long Range Radar Station. No DLP takes have occurred at industry sites since the Incidental Take Regulations (ITRs) were put in place in 1993, indicating that the mitigation measures associated with the regulations are effective. As bears spend more time onshore due to declining sea-ice conditions, there is an increased potential for human-bear interactions (Schliebe et al., 2008). Villagers in some coastal areas have reported more bears coming ashore earlier and staying longer. There have been reports from Fort Yukon and Noorvik of bears wandering much further inland than is usual (Anchorage Daily News 1/5/08, San Diego Union Tribune 3/28/08). In recent years, there also have been reports of cannibalism among adult polar bears, and cubs are at risk from adult male polar bears (Amstrup et al., 2006). When bears become concentrated onshore waiting for the ice to form, the likelihood of bear-bear interactions also goes up.

4.4.1.6.3.1.4. Potential Effects from Petroleum Spills. Exposure of polar bears to petroleum or other hydrocarbons could result from a number of ongoing or future events. Petroleum spills may occur as a result of ongoing industry activities, barge and other vessel traffic, accidents at sea, accidents onshore, equipment malfunctions, spills during bulk-fuel transfers, local village activities, or research activities. Most spills are expected to be of refined materials (diesel fuel, gasoline, antifreeze, etc.) and to be very small (Section 4.3.2).

Freshly spilled oil contains high levels of toxic aromatic compounds that can cause serious health effects or death if inhaled. Oil that moves some distance from a site still may have high levels of toxic aromatic compounds, depending on temperature and whether the oil becomes frozen into ice. Oil and other petroleum products are highly toxic when ingested. Petroleum products also can foul fur, leading to hypothermia.

Polar bears may come into direct contact with oil, ingest oil while grooming, or ingest oil by feeding on contaminated prey items. Polar bears' coats lose the ability to insulate when fouled with petroleum hydrocarbons. One study found that when two bears were purposely exposed to oil, both oiled bears immediately began grooming themselves in an attempt to clean their fur and suffered internal organ damage as a result of ingesting oil. One bear died of liver and kidney failure. The other bear was euthanized several weeks later and the subsequent necropsy revealed damage to liver, kidneys, and other organs (Oritsland et al., 1981). Bears are curious and will scavenge marine mammal carcasses when available. It is unclear whether polar bears would avoid petroleum hydrocarbon spills or contaminated

carcasses. There is some evidence that bears actively will investigate petroleum products, such as cans of oil and neoprene fuel bladders (Stirling, as cited in Geraci and St. Aubin, 1990; Amstrup, 1989; Derocher and Stirling, 1991).

Due primarily to increased fall concentrations of bears on parts of the Beaufort Sea coast, the potential for a large oil spill to impact polar bear populations on or near the coast has increased in recent years. Oil spills have a great potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large numbers of polar bears at coastal aggregations as well as in broken pack ice and lead systems offshore. Areas near Kaktovik, Cross Island, and Barter Island are particularly vulnerable. For example, 61 bears were observed on Bernard Spit near Barter Island in fall 2003 (Miller, Schliebe, and Proffitt, 2006). During winter and spring, when bears are less concentrated, the number of bears likely to be contaminated or indirectly affected as a result of a large oil spill on or near the coast would be smaller. Indirect effects to polar bears due to a spill include the possibility of local reductions in polar bear prey (ringed or bearded seals), displacement of bears or their prey due to cleanup efforts, and displacement from denning areas due to contamination or cleanup activities. The NRC has determined that a large spill (>1,000 bbl) in the Beaufort Sea would have major effects on polar bears and ringed seals (NRC, 2003b).

4.4.1.6.3.1.5. Potential Effects from Habitat Loss and Degradation. Habitat loss due to changes in arctic sea ice has been identified as the primary cause of decline in polar bear populations. The decline of sea ice is expected to continue throughout the polar bear's range for the foreseeable future and to lead to a further decline in the population (73 *FR* 28212-28303). For a more complete discussion of sea-ice decline, see Section 3.2.4.3. The SBS and the CS populations of polar bears inhabit the Polar Basin Divergent Ecoregion. This ecoregion is characterized by ice forming and then being drawn away from the nearshore area by wind and current, particularly in summer (Amstrup, Marcot and Douglas, 2007). The sea-ice decline is characterized by decreases in sea-ice extent and thickness and increases in the sea-ice retreat in spring and summer (see Section 3.2.4). This increased sea-ice retreat may eventually exclude bears from onshore denning habitat. Amstrup, Marcot and Douglas have projected a 42% loss of optimal summer polar bear habitat by 2050. This decline is expected to have major impacts for the SBS and CS populations of polar bear. Amstrup, Marcot and Douglas have projected that these populations will be extirpated within the next 45-75 years, if sea ice declines continue at current rates.

Some coastal and nearshore habitat loss may occur from the expansion of human activities in nearshore and coastal areas. New causeways, harbor facilities, or roads may cause loss of coastal habitat. For example, the proposed new airport and landfill at Kaktovik, and the proposed Endicott/Liberty expansion, both increase the human footprint on barrier islands. Barrier islands in the Beaufort Sea have been identified as a preferred habitat of polar bears (Evans, 2008, pers. commun.).

4.4.1.6.3.1.6. Potential Effects from Seismic Noise. Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). Because effective seismic surveys are relegated to operating in an ice-free environment, it is unlikely that open-water seismic activities will impact polar bears or the abundance and availability of ringed and bearded seals, which are the primary prey of polar bears. Because seismic operations typically are not concentrated in any one area for extended periods, any impacts to polar bears should be relatively short in duration and should have a negligible impact on polar bear populations.

Impacts to polar bears from marine open-water seismic activity have not been studied, but likely would be minor. Polar bears normally keep their heads above or at the water's surface when swimming, where underwater noise is weak or undetectable (Richardson et al., 1995a). Direct impacts potentially causing injury from open-water seismic surveys are possible if animals entered the 190-dB zone immediately

surrounding the sound source. There also is the possibility that bears could be struck by seismic vessels or exposed to small-scale fuel spills, although these risks are considered unlikely to occur.

For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup, 1993). However, pregnant females and those with newborn cubs in maternity dens are sensitive to noise and vehicular traffic (Amstrup and Garner, 1994). On-ice seismic surveys have the potential to disturb female polar bears in dens along the coast or on shorefast ice.

Vessel traffic associated with seismic-survey activity is not expected to cause impacts to polar bears, because polar bears show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Seismic surveys have the potential to disturb polar bears that are swimming between ice floes or between the pack ice and shore. Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land. Bears that encounter seismic operations may be temporarily deflected from their chosen path, and some may choose to return to where they came from. However, bears swimming to shore are most likely heading for reliable food sources (i.e., areas where ringed seal concentrations are high or Native-harvested marine mammal carcasses on shore), for which they have a strong incentive to continue their chosen course. Therefore, although some bears may be temporarily deflected and/or inhibited from continuing toward land due to seismic operations, this interruption likely would be brief in duration. For bears that are already severely energetically stressed, however, this could prove fatal. Due to the vast area over which seismic surveys will be conducted, and the fact that seismic operations will be curtailed during the bowhead migration (due to aggregations of migrating whales), which coincides with the time that large numbers of bears swim for land, the number of bears affected in this manner likely would be very small. Steps taken to avoid conflicts between seismic operations and bowhead whale-subsistence hunts also would benefit polar bears. Because the whale hunts coincide with the time that many bears come ashore, particularly in the Kaktovik area, the impact to swimming polar bears would be mitigated to some extent. Ultimately, few bears are likely to be substantially affected by seismic operations during the open-water period.

On-ice seismic operations that take place nearshore, or land-based seismic operations that take place nearshore, could impact polar bears through displacement of bears or their prey. Polar bears could be displaced from preferred denning habitat in some instances. Polar bears also could be displaced from shorefast ice, which is where ringed seals tend to have their lairs and, therefore, be forced to forage in less productive areas. Displacement of polar bears or ringed seals would be relatively short term, lasting only for the duration of the surveys. Displacement of denning polar bears could have more serious consequences. However, because FWS requires that den surveys be conducted prior to the onset of seismic activities in areas where dens may occur, it is unlikely that denning bears would be affected in most instances. Mitigation measures required by FWS have proven to be very effective, and impacts from on-ice seismic activities are expected to be minor.

4.4.1.6.3.1.7. Cumulative Effects from Global Forces. According to FWS, the status of polar bears worldwide is declining primarily as a result of climate change and the resultant loss of sea-ice habitat (Final Polar Bear Rule 73 *FR* 28212-28303). The recent release of the Arctic Climate Impact Assessment's report on *Impacts of a Warming Arctic* (ACIA, 2004), combined with a peer-reviewed analysis of the effects of climate change on polar bears by three of the world's foremost polar bear experts (Derocher, Lunn, and Stirling, 2004) indicate that polar bears are facing a cascading array of effects as a result of dramatic changes to their habitat. Observed changes to date include reduced sea-ice extent, particularly in summer (Section 3.2.4.3), and progressively earlier sea-ice breakup dates, especially in

more southerly areas. For a more in-depth review of the effects of climate change upon polar bears, see Section 3.3.4.3.

Projected impacts to polar bears from climate change would affect virtually every aspect of the species' existence. The timing of ice formation and breakup will determine how long and how efficiently polar bears can hunt seals. Reductions in sea ice will result in increased distances between the ice edge and land which, in turn, will lead to increasing numbers of bears coming ashore during the open-water period, or drowning in the attempt. Reductions in sea ice also will also increase the polar bears' energetic costs of traveling, as moving through fragmented sea ice and open water is more energy intensive than walking across consolidated sea ice. Reductions in sea ice may result in reduced availability of ringed seals, and would result in direct mortalities of bears from starvation. Continued climate change also likely would increase the occurrence of bear-human interactions on land. All of these factors are likely to result in impacts to polar bear populations and distribution.

4.4.1.6.3.2. Mitigation Measures. The mitigation measures in effect for ongoing OCS activities that result from previous Beaufort Sea sales can be found in USDOJ, MMS (2003a) and at www.mms.gov/alaska/ref/EIS%20EA/BeaufortMultiSaleFEIS186_195_202/2003_001vol1.pdf. These mitigation measures include stipulations that have mitigation effects for polar bears.

Under the MMPA and ESA, the FWS is responsible for polar bears, sea otters, walruses, and birds. Procedural regulations implementing the provisions of the MMPA for FWS are found at 50 CFR Part 18.27. Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA (16 U.S.C. 1371(a)(5)) allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area, as long as such take is determined to have a "negligible" effect on the population. Section 7(b)(4) of the ESA (16 U.S.C. 1536(b)(4)) allows for the incidental taking of endangered and threatened species under certain circumstances, as long as such take is not determined to have a population-level effect. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Incidental, but not intentional, taking is authorized only by U.S. citizens holding an LOA issued pursuant to these regulations. An LOA or IHA must be requested annually. Behavioral disturbance of most birds and mammals found in or near the lease area would be unlikely if aircraft and vessels maintain at least a 1-mile horizontal distance and aircraft maintain at least a 1,500-foot vertical distance above known or observed wildlife concentration areas, such as bird colonies and marine mammal haulout and breeding areas. For the protection of endangered whales and marine mammals throughout the lease area, it is recommended that all aircraft operators maintain a minimum 1,500-foot altitude when in transit between support bases and exploration sites. Lessees and their contractors are encouraged to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered polar bears are likely to be in the area. Human safety will take precedence at all times over these recommendations. The current Beaufort Sea ITR for polar bear include mitigation, monitoring and reporting requirements for operators. Each request for an LOA is carefully reviewed by the FWS, and LOAs may include conditions to afford additional protections to sensitive areas, such as denning habitats.

Current ITR for the Beaufort Sea remain in effect until August 2, 2011. When the polar bear was listed under the ESA on May 15, 2008, FWS conducted an intra-agency consultation on the MMPA Beaufort Sea ITR and determined that the LOA process under the MMPA was not likely to jeopardize the continued existence of the polar bear. The FWS also has determined that the LOA process provides sufficient protection for the polar bear to serve as adequate consultation under the ESA. Therefore, a company has met its obligations under the ESA as long as they obtain and follow the requirements of an

LOA. An LOA will not be issued to a company unless their proposed activity has been determined to have no more than negligible effects on the polar bear. Mitigation measures required through the LOA process typically include notifying FWS within 24 hours of any sighting of or interaction with a polar bear.

Additional mitigation may be required by FWS through the MMPA and the ESA. The FWS has MMPA ITR currently in effect for the Beaufort Sea (71 *FR* 43926-43953). These regulations remain in effect from August 2, 2006, through August 2, 2011. The regulations for Beaufort Sea oil and gas activities encompass exploration, development, and production activities. Mitigation measures applied through the ITR may include FLIR imagery flights to determine the location of active dens, avoiding all denning activity by a minimum of 1 mile, intensified monitoring of an area or avoiding the area during the denning period. In some instances, work camps or facilities may be relocated to avoid potential interactions with polar bears. Aerial surveys may be required to locate bears in the area. These mitigation measures will vary depending upon the type of industry activity, the location, time of year and other factors.

4.4.1.6.3.3. Anticipated Effects Under Alternative 1.

4.4.1.6.3.3.1. Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts to polar bears from Alternative 1, No Lease Sale. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.6.3.3.2. Cumulative Effects Under Alternative 1. The cumulative impacts of selecting Alternative 1 are based on the existing natural environment and current anthropogenic ongoing actions in the Beaufort Sea. Primary considerations for polar bears include anticipated environmental changes that will have major impacts for the polar bear, even if neither lease sale is held. Continued climate change and loss of sea-ice habitat likely would lead to the extirpation of the polar bear from Alaska within the next 45-75 years (Amstrup, Marcot, and Douglas, 2007).

4.4.1.6.3.3.2.1. Anticipated Level of Cumulative Effects to Polar Bears. This section describes the impact on polar bears resulting from the incremental impact of neither lease sale being held and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions are described in Section 3.1. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures (described in Section 4.4.1.6.3.2) and the following important factors are considered in determining the anticipated effects from this alternative.

Timing. The window of time for exploration typically includes the open-water period. This largely eliminates most potential effects to polar bears, unless exploration vessels traverse the spring lead system. Currently, seismic activities are restricted in the spring lead systems until after July 15. For production, operations would take place year-round, and effects would be possible from a variety of sources throughout the year.

Residence Time and Periodicity. Effects vary based on whether activity in the area is short term or long term, and whether it involves passage through an area on a frequent or intermittent basis. During exploration, drillships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft likely would need to make trips between the drillship and shore to deliver personnel and equipment. Seismic vessels may operate for 20-30 days in a specific area. Residence time and periodicity of drillships, seismic vessels and support vessels during exploration could affect polar bear movements, depending on location and timing.

Spatial Extent. The lease-sale area is large, and the area explored in any given season is small by comparison. Beyond the footprint of a seismic vessel or drillship, consideration must be given to the area affected by noise, support-vessel traffic, and other secondary factors that could affect polar bears.

Oil Spills. We recognize that if an oil spill occurred where there were concentrations of polar bears, large-scale mortality could occur, representing a major population-level effect. Large spills could arise from a variety of sources, especially during bulk fuel deliveries or other marine accidents. A very -large spill from a well blowout is described as a very unlikely event in Appendix A.

Extent of mortality that could result from oil spills from oil production (currently viewed as being speculative until a large commercially developable OCS field is discovered) is extremely difficult to estimate. First, it is uncertain that oil would be discovered. The potential that a commercial field would be discovered in the Chukchi Sea is $\leq 10\%$ and about 20% in the Beaufort Sea. Secondly, it also is uncertain that oil would be spilled. As stated in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), the likelihood of at least one spill of at least 1,000 bbl (42,000 gal) during the life of the project (approximately 26 years) is currently estimated to be 8-10%. The extent of mortality from such an improbable spill would be influenced greatly by the location, volume, trajectory, and timing of the spill, weather conditions, as well as the period that oil remains in the environment.

Following production, a larger number of small spills (<1,000 bbl) could occur, but most of these would be into containment (not the open ocean). In addition, the low probability of such events combined with the uncertainty of the location of the spill make it highly unlikely that numerous chronic small spills or a large oil spill would contact large numbers of polar bears. For example, 1600 Bbls of heating oil were reportedly spilled into the Beaufort Sea near Kaktovik in 1988. No oiled birds or other wildlife were discovered, and the U.S. Coast Guard closed the case.

Considering the estimated mean number of spills, the chance of one or more large spills occurring, coupled with a variety of other factors that would need to occur simultaneously to result in polar bear mortality, we anticipate that it is highly unlikely that major impacts will result from oil spills associated with OCS oil and gas activities within the Chukchi Sea or Beaufort Sea lease-sale areas. The MMS requires companies to have and implement oil-spill-response plans (OSRPs) to help prevent oil from reaching critical areas and to remove oil from the environment. In addition, the FWS requires companies to provide OSRPs for review before they will issue an LOA. For purposes of the following analyses, numerous small spills or large spills from OCS oil and gas activities are considered high effect, low likelihood events and are not considered reasonably foreseeable.

For the same reason, it is difficult to estimate the potential for chronic small spills or a large spill to originate from private, commercial, or State sources within the Chukchi or Beaufort seas. Increasing vessel traffic in general and bulk fuel deliveries in particular, appear to present some danger of an oil spill to polar bears.

4.4.1.6.3.3.2.2. Anticipated Level of Effects from Vessel Traffic.

Summary. Vessel presence and noise are anticipated to result in negligible impacts to polar bears.

Section 3.1.3.2 describes the general past and present vessel-traffic patterns in the Beaufort Sea. Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research vessels in the Arctic. We anticipate this trend to continue into the reasonably foreseeable future.

There is a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific and the Atlantic oceans. Increasing military activities also are anticipated. An increase in icebreaker traffic could disturb polar bears and potentially disrupt movement patterns or displace bears from preferred foraging areas.

Mitigation measures required on exploration and development activities avoid or minimize adverse effects to polar bears in the Beaufort Sea. Polar bears remain offshore in the pack ice, or onshore during the open-water season and are unlikely to be impacted by vessel traffic. OCS actions could result in a small incremental increase in the total number of vessels operating in the Beaufort Sea.

4.4.1.6.3.3.2.3. Anticipated Level of Effects from Motorized Vehicle Presence and Noise.

Summary. Aircraft and motorized vehicle traffic and noise are anticipated to result in continued minor effects on polar bears.

Aircraft and motorized vehicle traffic and noise could adversely affect polar bears by: (1) displacing bears from preferred habitats during denning; (2) displacing bears from preferred foraging habitats; (3) reducing foraging efficiency and feeding time; (4) causing bears to abandon dens prematurely; (5) disrupting movements onshore and offshore; and (6) causing heat stress and/or unnecessary energetic expenditures. While some polar bears tolerate noise and activity in close proximity, others do not. Individual tolerances are expected to vary, and the intensity of disturbance, in most cases, would be minor.

Most aircraft on the North Slope are operated without altitude or route restrictions, and most nonindustrial vehicles are operated without restrictions. Frequent traffic associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact some bears, but at an unknown level. Any minor adverse effects are anticipated to continue.

Mitigation measures imposed on exploration and development activities would avoid or minimize adverse effects to polar bears in the Beaufort Sea. These may include minimum flight elevations in certain areas and flight restrictions around denning areas. While there likely would be an incremental increase in the total amount of activity, appropriate mitigation would be imposed by FWS through the LOA process. With mitigation, impacts would likely be negligible. The FWS has determined that routine air traffic is likely to have little or no effect on polar bears.

4.4.1.6.3.3.2.4. Anticipated Effects from Subsistence and Other Harvests.

Summary. We anticipate that subsistence take of polar bears will continue to be managed cooperatively through the Inuvialuit-Inupiat Polar Bear Management Agreement, and that overharvest will not occur. Any increase in the numbers of polar bears remaining onshore near human habitation, or an increase in the duration of time that polar bears spend onshore, may lead to an increase in DLP take.

Mitigation measures in place throughout the North Slope decrease the likelihood of polar bear DLP takes. Typically, polar bears may be hazed away from platforms or industrial camps to eliminate the potential risk to humans or bears. No bears have been taken in relation to industry activities since MMPA ITR went into effect in 1993.

4.4.1.6.3.3.2.5. Anticipated Effects from Petroleum Spills.

Summary. This alternative is anticipated to result in minor effects to polar bears, because petroleum spills are considered infrequent illegal or accidental events.

The potential effects of spills on polar bears were described in Section 4.4.1.6.3.1.4. Spills on or near barrier islands in fall or winter or in the marine environment have the greatest potential to affect polar bears. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings. Particular concern has been expressed over increases in shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas. Vessels traversing the Chukchi and Beaufort seas during periods when ice is present are more prone to an accident.

Other sources of petroleum spills include a well blowout or other contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea or on lease lands in the Canadian Beaufort. These are modeled as having a low chance of occurring and, therefore, are unlikely to have adverse effects on polar bears. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4.

If a large oil spill occurred in the vicinity of an aggregation of polar bears, any substantial loss of individual bears would represent a major impact. However, the Beaufort Sea Sale 186/195/202 OSRA estimates the chance of one or more large oil spills from OCS production to be very low. The most likely number of spills $\geq 1,000$ bbl is zero (USDOJ, MMS, 2003a:Appendix A).

In the unlikely event of such an oil spill, the extent of take would be influenced greatly by the volume, trajectory, and timing of the spill as well as the period that oil remains in the environment (Section 4.4.1.6.3.1.4). Polar bears present in the vicinity of an oil spill might or might not be contacted by the oil due to avoidance behavior, ice conditions, or weather patterns. It is unclear whether polar bears avoid or are attracted to oil (Geraci and St. Aubin, 1990). Companies are required to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment.

4.4.1.6.3.3.2.6. Anticipated Effects from Habitat Loss and Degradation.

Summary. Anthropogenic effects of Alternative 1 are anticipated to result in minor impacts on polar bear denning habitat because of incremental increases in infrastructure for community and industrial development. Existing human development in coastal areas of the Chukchi and Beaufort seas is limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Development likely will occur in the future, and it is possible that some amount of polar bear denning habitat may be lost.

Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future loss of polar bear habitat in the Beaufort Sea region. Some aspects of these actions would require Federal permits that would require Section 7 consultation under the ESA, which likely would result in minimizing adverse effects of habitat loss. Critical habitat, as defined by the ESA, has not yet been delineated for the polar bear. At this time, FWS is in the process of determining critical habitat for the polar bear. Once this process is complete, additional protections for these critical habitat areas may be instituted.

Habitat loss due to changes in climactic conditions, particularly changes in sea-ice extent and stability, are expected to have major effects on the polar bear. Major impacts to polar bears are expected to come from the continued loss of the sea-ice habitat that polar bears rely on.

There would not be any permanent loss of polar bear habitat during exploration and delineation activities. Some displacement of polar bears and their prey (e.g., ringed seals) may occur. The level of this impact would depend on the extent of habitat involved and the duration and timing of the activities.

Offshore developments currently planned in the Beaufort Sea include Liberty and Nikaitchuq. The Liberty development is expected to be an extended-reach drilling project linked to facilities onshore and to Endicott. Reasonably foreseeable future developments in the Beaufort Sea include Sivuliq, Thetis Island, Sandpiper, and others (see Table 3.1.1-1).

When development and production occurs, facilities will be constructed to extract and transport product to existing processing facilities. Permanent habitat loss could occur, if production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas used by polar bears for denning or in optimum foraging habitats.

Direct impacts to polar bear denning habitats could arise from the facility footprint. We can only speculate about the size and location of permanent developments associated with a future phase of oil production, but developments on offshore barrier islands, a habitat preferred by polar bears, could have moderate effects over time. Onshore developments would originate at a pipeline landfall, the location of which is unknown. The pipeline and associated developments conceivably would then be the shortest, most cost-effective route to connect with pre-existing support infrastructure. We expect effects to polar bears from currently planned and reasonably foreseeable actions to be minor or moderate over time, depending on the location of developments and potential changes in polar bears' use of the nearshore environment due to climate change.

4.4.1.6.3.3.2.7. Anticipated Effects from Seismic Noise.

Summary. Polar bears are more likely to be affected by on-ice seismic surveys than by open-water surveys. Ongoing exploration activities are occurring in the Beaufort Sea on areas leased by the State of Alaska. Some displacement may occur, but these effects are expected to be short term and sublethal. There is at least one record of seismic activity disturbing a bear while she was in a den (NRC, 2003).

Exploration by on-ice and open-water seismic surveys are occurring on areas leased in the Beaufort Sea (Lease Sales 186, 195, and 202). Seismic surveys also take place off-lease. Most effects from seismic activity are expected to be minor due to mitigation measures currently in place, such as conducting den surveys prior to the onset of work, and avoiding any known dens by a prescribed distance.

4.4.1.6.3.3.2.8. Anticipated Effects from Changes in the Physical Environment.

Summary. Specific future effects from climate change are difficult to predict with any certainty; however, we expect current trends to continue and to accelerate over time (IPCC, 2007). If current trends continue as predicted, polar bears from the Beaufort Sea population may spend more time onshore fasting, or spend more time on sea ice that has retreated over deepwater not suitable for their principal prey. There may be declines in abundance and availability of ringed and other ice seals as prey items. Current declines in fitness (as measured by weight, fat reserves, and fecundity) may also continue. We anticipate that these ongoing trends will have major impacts on the polar bear, and that these trends are likely to adversely affect the polar bear.

In addition, worldwide trends in demand, production, and consumption of hydrocarbons also are expected to continue for the foreseeable future. The current trend in anthropogenic influences on climate change caused by oil and gas use and development also are expected to continue.

We expect exploration of existing Federal leases in the Beaufort Sea OCS to continue. Leaseholders and others will continue to investigate the potential for oil and/or gas production in the future. Authorized activities will contribute incrementally to production levels worldwide and to the positive and negative effects of this production.

4.4.1.6.3.4. Summary of Effects on the Polar Bear. The cumulative effects analysis section describes the anticipated effects of the no action alternative in the Beaufort Sea. As there would be no effects from this alternative in the project area, the anticipated effects in this case, are the cumulative effects for this alternative (Section 4.4.1.6.3.3.2). For each of the other alternatives, the anticipated effects from Alternative I (Section 4.4.1.6.3.3) will be combined with the anticipated effects from each of the remaining action alternatives to determine the cumulative effect for that alternative.

4.4.1.7. Marine and Coastal Birds.

Summary. In the following analysis we determined that there would be no direct or indirect effects if the lease sales were not held, there would be a negligible cumulative level of effect from seismic surveys, subsistence hunting, and petroleum spills, and a continued minor cumulative level of effect from vessel presence and noise, aircraft presence and noise, collisions with structures, loss of habitat, and increased predator populations. The greatest potential for a major level of effect is associated with continuing physical changes in the Arctic environment. Mitigation measures imposed by MMS on future exploration and development activities on existing leases and surrounding waters avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. The total effect of MMS-authorized actions would be proportionately lower when compared to similar, but unrestricted activities in the area.

This section describes the impact on marine and coastal birds resulting from the direct and indirect effects of the action (which for this alternative is taking no action) and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions that affect marine and coastal birds are described in Section 3.1. Reasonably foreseeable future actions are described in Section 4.2.

4.4.1.7.1. Potential Effects to Marine and Coastal Birds. Marine and coastal birds in the Chukchi and Beaufort seas are subject to the same potential effects from a variety of existing sources described for threatened and endangered birds in Section 4.4.1.6.2.1.

4.4.1.7.2. Mitigation Measures. Our effects analysis considered mitigation measures described in Section 4.4.1.6.2.2.

4.4.1.7.3. Anticipated Effects Under Alternative 1. Our effects analysis considered other important factors (timing, residence time and periodicity, spatial extent, environmental factors, etc.) are described in Section 4.4.1.6.2.3. We also defined the level of effect terms in Section 4.4.1.6.2.3.

The anticipated effects under this alternative are separated into direct and indirect effects (Section 4.4.1.7.3.1) and cumulative effects (Section 4.4.1.7.3.2). As marine and coastal birds are a resource group, we address differential effects to specific species separately in Section 4.4.1.7.4.

4.4.1.7.3.1. Anticipated Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts to marine and coastal birds from Lease Sale 209 or 217 if these sales were not held.

4.4.1.7.3.2. Cumulative Effects Under Alternative 1.

Summary. Marine and coastal birds would continue to be exposed to a variety of potential negative effects including disturbances, collisions, habitat loss, petroleum exposure, and increased predator populations during the reasonably foreseeable future. The greatest potential for substantial adverse impacts would arise from collisions and vessel/aircraft disturbance in important coastal bird habitats, especially nearshore migration routes. Other important areas include barrier islands and large river deltas. Barrier islands provide important nesting, molting, and migration habitat to a variety of waterfowl and shorebirds. While Federal oil and gas exploration activities may result in a small increase in numbers of some activities (vessel or aircraft trips) that could affect birds, mitigation measures would reduce the incremental contribution of these additional impacts to negligible or minor level of effect for marine and coastal birds in the Beaufort Sea area. Other than a major level of effect from climate change influencing the abundance and distribution of key bird habitats, no population-level effect to marine and coastal birds is anticipated.

This section describes the impact on marine and coastal birds resulting from the incremental impact of the no action alternative and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions are described in Section 3.1 as they affect marine and coastal birds. Section 4.2 describes the reasonably foreseeable and speculative future events. This analysis essentially describes what anticipated effects will occur in the future if MMS does not hold any future lease sales in the Beaufort Sea.

4.4.1.7.3.2.1. Anticipated Level of Effect from Vessel Presence and Noise. Section 3.1.3.2 describes the general past and present vessel-traffic patterns in the Beaufort Sea. Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research vessels in the Arctic, such as those seeking to explore and study Arctic regions via the Northwest Passage. We anticipate this trend to continue into the reasonably foreseeable future. These vessels are free to navigate open or ice-laden waters where they could encounter and disturb coastal and marine birds. For example, vessel traffic between the Beaufort Sea and the Bering Sea could pass through areas seasonally important to a variety of coastal and marine birds using the spring lead system of the Chukchi Sea.

There is a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific Ocean and the Atlantic Ocean. Increasing military activities also are anticipated. As with tourism and research traffic, both commercial and military large-vessel traffic could disturb large numbers of coastal and marine birds. Uncontrolled vessel disturbance from anticipated tourism, research, shipping, and military vessels could result in chronic, long-term disturbances to marine and coastal birds across the Beaufort Sea.

Oil and gas exploration and development in nearshore waters under State jurisdiction could add to disturbance potential experienced by marine and coastal birds in the Beaufort and Chukchi Sea regions; however, there may be mechanisms via the State permitting process to implement mitigation measures to reduce vessel impacts to ESA-listed birds (eiders) that also will benefit other marine and coastal birds in the Beaufort Sea.

Mitigation measures required on future exploration and development activities from existing leases and surrounding waters avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. The total effect of OCS actions would be proportionately lower when compared to similar, but unrestricted activities in the area.

Summary. Vessel presence and noise under Alternative 1 are anticipated to result in a continued minor level of effect on marine and coastal birds.

4.4.1.7.3.2.2. Anticipated Level of Effect from Aircraft Presence and Noise. Aircraft traffic could adversely affect marine and coastal birds by: (1) displacing adults and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. The behavioral response of marine and coastal birds to low-level flights is unknown; some species are more sensitive than others and individual tolerances are expected to vary. Some birds may be displaced, with unknown physiological and reproductive consequences.

Most aircraft on the North Slope are operated without altitude or route restrictions to protect marine and coastal birds. Some traffic associated with State oil and gas operations is restricted to protect certain species that also may benefit marine and coastal birds (ADNR, 2008). Frequent low-level flights associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact marine and coastal birds, but at an unknown level. Any adverse effects are anticipated to continue.

The number of nesting marine and coastal birds that would be exposed to low-level flights associated with OCS oil and gas development from existing leases and surrounding waters is low, because the potential direct flight from an airbase to offshore drilling sites within the OCS primarily would be over coastal waters. Mitigation measures imposed on future exploration and development activities avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. The total effect of OCS actions would be proportionately lower when compared to similar, but unrestricted activities in the area.

Summary. Aircraft presence and noise under Alternative 1 are anticipated to result in a continued minor level of effect on marine and coastal birds.

4.4.1.7.3.2.3. Anticipated Level of Effect from Collisions. Some species of marine and coastal birds, particularly long-tailed ducks and common eiders, will continue to strike structures during periods of darkness or inclement weather in nearshore areas. Some facilities are lit in such a manner that may attract and disorient flying birds, resulting in avoidable impacts if improvements to lighting were made. The NSB has proposed to reconstruct/relocate the existing airport on Barter Island. This airport services Kaktovik. The project proposes to run a power line to the new sites, which could increase the number of migratory birds killed.

Monitoring of bird-strike mortality across the North Slope is infrequent, so the level of mortality cannot be estimated. The FWS maintains a database of reported collisions (USDOJ, FWS, 2008). The MMS review of this database indicates the level of mortality to marine and coastal birds appears low.

Oil and gas development in nearshore waters under State jurisdiction could add to collision potential experienced by marine and coastal birds in the Beaufort and Chukchi Sea regions.

While there could be an incremental increase in the total number of structures, these structures would have proportionately fewer impacts compared to other structures in the project area. Mitigation measures imposed on future exploration and development activities on existing leases and surrounding waters would minimize collision mortality to marine and coastal birds in the Beaufort Sea.

We cannot assume that recommendations for the design and implementation of lighting of structures would result in no strikes by marine and coastal birds, and some collision mortality is anticipated for common and king eiders and long-tailed ducks. Although production from existing Beaufort Sea leases is

speculative, and despite future efforts to avoid attracting waterfowl to structures, a relatively small number of marine and coastal birds could continue to die from collisions with structures associated with production drilling on existing leases in the Beaufort Sea OCS.

Summary. Collisions resulting from Alternative 1 are anticipated to result in a continued minor level of effect on marine and coastal birds in the Beaufort Sea.

4.4.1.7.3.2.4. Anticipated Level of Effect from Petroleum Spills. The potential effects of spills on marine and coastal birds were described in Section 4.4.1.6.2.1.4. While spills can occur on land or in the marine environment, spills in the marine environment have the greatest potential to affect large numbers of marine and coastal birds. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Vessels traversing the Chukchi and Beaufort seas during period of ice are more prone to an accident. The ADEC (2007) reported that the highest probability of spills of noncrude products occurs during fuel-transfer operations at the remote villages of the North Slope.

Other sources of petroleum spills include a well blowout or other oil spills/toxic contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea, but these are modeled as having a low percent chance of occurring and it is improbable that adverse effects to marine and coastal birds from these activities would occur. A large spill from a well blowout is described as a very unlikely event in Section 1.1.4.

The potential for spills from OCS activities to contact marine and coastal birds from existing leases and surrounding waters in the Beaufort Sea were described in the Beaufort Sea Planning Area Oil and Gas Sales EIS and were best summarized in the BO prepared by the FWS for the Beaufort Sea Oil and Gas Lease Sales 186, 195, and 202 final EIS (USDOJ, MMS 2003a:Appendix C):

If a large oil spill occurred in the location of and during spectacled eider presence, spectacled eider mortality would be <individuals; however any substantial loss (25+ individuals) would represent a significant effect (MMS Lease Sale 186). It is unlikely that take of Steller's eiders will result from a large oil spill in late spring or in early summer unless atmospheric and oceanic conditions were such that spilled oil dispersed towards Barrow and into the Chukchi Sea. The MMS's Lease Sale 186 Oil-Spill-Risk-Analysis modeling runs predict the probability of such a spill scenario to be very low.

Extent of take that will result from oil spills from the proposed action is extremely difficult to estimate. First, it is uncertain that oil will be spilled. As stated in the biological evaluation, the likelihood of at least one spill of at least 1,000 bbl (42,000 gal) during the life of the project (~26 years) is currently estimated to be 8-10 percent. In the unlikely event of such an oil spill, the extent of take will be greatly influenced by the number, volume, trajectory, and timing of spills as well as the period that oil remains in the environment. In addition, the low probability of such an event, combined with the uncertainty of the location of the spill, and the seasonal nature of the resources inhabiting the area, make it highly unlikely that a large oil spill would contact a threatened eider. Spectacled and Steller's eiders are present on the North Slope for only 3-5 months out of the year. Even if an eider were present in the vicinity of an oil spill, it might not be contacted by the oil due to avoidance behavior, ice conditions or weather patterns. Furthermore, the MMS requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment. Therefore, the probability of a large oil spill contacting a Steller's or spectacled eider is much less than 8-10 percent over the 30 year life of the proposed leases (2003-2033).

Considering the low probability of a large spill coupled with a variety of other factors that would need to be satisfied to result in take, the Service anticipates that it is highly unlikely that incidental take of listed eiders will result from oil spills within the Lease Sale 186 area. However, should any oil spill within the Lease Sale 186 area result in the take of any Steller's or spectacled eider, the MMS will immediately cease all operations responsible for the take pending reinitiation.

Summary. This alternative is anticipated to result in a negligible level of effect on marine and coastal birds because petroleum spills are considered infrequent illegal or accidental events.

4.4.1.7.3.2.5. Anticipated Level of Effect from Increased Bird Predator Populations. The dependence of ravens on human-use foods and garbage, combined with the potential increase in nesting sites from existing and future developments, are anticipated to continue and will result in the expansion in the distribution and abundance westward across the North Slope. Only a concerted management program to deny ravens access to artificial food sources and removal of nests or ravens would halt the facilitated expansion of breeding ravens across the North Slope. This is not anticipated to occur in the reasonably foreseeable future, and moderate adverse effects to marine and coastal birds are anticipated to continue.

A similar, but potentially lesser, impact occurs from foxes obtaining human-use foods/garbage or denning in sites made suitable from development. While foxes are endemic to the North Slope, densities may be greater due to increased availability of food or den sites.

Mitigation measures imposed on future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of structures or facilities that could be used by bird predators such as ravens or foxes, these facilities would not be constructed or operated in a manner that would support bird predators.

A lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) recently has been implemented for the Liberty project and is anticipated to be implemented for future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the Beaufort Sea OCS. For this reason, no increase in predator populations is anticipated to occur from future OCS actions.

Summary. Alternative 1 is anticipated to result in a continued minor level of effect on marine and coastal birds.

4.4.1.7.3.2.6. Anticipated Level of Effect from Subsistence Hunting Activity. The legal harvest of marine and coastal bird resources is expected to continue at current levels; however, other projects could increase the duration and range of access for subsistence hunting. For example, the NSB has proposed to reconstruct all or part of the existing airport on Barter Island. This airport services Kaktovik. One alternative would construct a 5.4 mi road to a new airport on the mainland. The community has favored this alternative for a number of reasons, including increased access to hunting areas (HDL, 2008).

We assume future production developments from existing leases and surrounding waters to be speculative. If additional recoverable amounts of oil or gas in the Beaufort Sea are discovered and produced, a pipeline likely would carry products to pre-existing infrastructure for transport to processing facilities. The pipeline would need a road for periodic maintenance, and this road could increase access

of local hunters to previously inaccessible areas. Waterfowl hunters may be able to access pipeline roads during the period immediately following spring breakup to hunt geese and other waterfowl. We anticipate that any potential increased access would not influence the degree legal harvest of marine and coastal bird resources.

Summary. Alternative 1 is anticipated to result in certain activities that could affect marine and coastal birds, but these are legal harvests and a negligible level of effect is anticipated to result from increased access.

4.4.1.7.3.2.7. Anticipated Level of Effect from Habitat Loss. Existing human development in coastal areas of the Chukchi and Beaufort seas is relatively sparse and limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik. Continued development likely will occur in the future, and a corresponding amount of marine and coastal bird nesting habitat will be lost. For example, the Arctic Slope Native Association proposed to place gravel fill in about 10 acres of wetlands at Barrow (U.S. Army Corps of Engineers, 2006) to construct a new building. Similarly, the State of Alaska is managing a project to fill another 19 acres of wetland habitats to expand the Barrow Airport (U.S. Army Corps of Engineers, 2007).

Further east, the NSB has proposed to reconstruct all or part of the existing airport on Barter Island. This airport services Kaktovik. One alternative would place approximately 1.2 million cubic yards of gravel into wetlands and other habitats on the mainland within the Arctic National Wildlife Refuge (ANWR). Gravel would be from new gravel mines within ANWR. Another alternative, Alternative 3, included a 5.4 mile gravel road, two bridges, a new runway, and a hangar pad. The minimum estimated footprint from this new facility is 571 acres (230 km²) of direct impact and 1,129 acres (458 km²) of secondary impacts to bird nesting habitats as calculated using methodologies in recent Biological Opinions for Section 7 consultations. The combined loss of nesting habitat could be 1,700 acres (688 km²). A second alternative would have a smaller footprint, but would include the relocation of the existing landfill to a site farther south on the island (HDL, 2008). Secondary effects from the zone of influence around new or expanded developments also would result in the loss of marine and coastal bird habitat.

The closest industrial development of size southwest of the proposed lease areas is the Red Dog Mine Portsite near Kivalina, and existing industrial development (Kuparuk and Prudhoe Bay fields) are east of Teshekpuk Lake. Small amounts of development likely will occur in and around these sites in the future, and correspondingly small amount of marine and coastal bird nesting habitat will be lost. Secondary effects from the zone of influence around new or expanded developments also would result in habitat loss. For example, in April 2008, BPXA applied to the U.S. Army Corps of Engineers for three Section 404 permits to fill over 28 acres of wetlands “to support placement of infrastructure for oil and gas development” or similar purposes (U.S. Army Corps of Engineers, 2008). Secondary impacts to nesting birds could be smaller due to existing developments nearby. The project sites could affect nesting habitat for numerous species of marine and coastal birds. Conservation of marine and coastal bird habitats seldom is a pivotal factor in decisions by the Corps of Engineers whether or not to permit wetland fills, and most permits are granted without compensatory mitigation for net loss of wetland habitats.

Oil and gas exploration or development in nearshore waters under State jurisdiction could add to future marine and coastal bird habitat loss in the Beaufort Sea region. As many marine and coastal bird species benefit from mitigation measures developed specifically to benefit ESA-protected birds, future Section 7 consultation under the ESA likely would result in minimizing adverse effects of habitat loss to marine and coastal birds.

There would not be any permanent loss or alteration of marine and coastal bird habitat during exploration and delineation activities from existing leases and surrounding waters. Small amounts of temporary habitat loss of marine and coastal bird migration habitats could occur from drilling exploration or delineation wells into the seafloor. Benthic habitats used by birds could be disturbed and/or altered by drilling exploratory or delineation wells in the seafloor, but these well site areas would be small and would be expected to return to predrill condition in fewer than 3 years.

Future production of oil or gas resources from existing leases on the Beaufort Sea OCS remains speculative but if it were to occur, facilities would be constructed to extract and transport product to existing processing facilities. Permanent habitat loss could occur if production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas used by marine and coastal birds. Indirect habitat losses could result from marine and coastal birds not using habitats near sites of industrial activity.

Direct impacts to marine and coastal bird nesting habitats arise from the facility footprint. We can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production from the OCS, but it can be estimated. These estimates are described in Section 4.4.1.6.2.1.7, Anticipated Effects from Habitat Loss (Threatened and Endangered Birds) and summarized in Table 4.4.1.6.2-1. Overall, these development facilities have an estimated collective areal extent of 3.41 km² (845 acres) in marine and coastal bird nesting habitats. The secondary zones of influence associated with development facilities have an estimated collective areal extent of 33 km² (8,327 acres) in bird nesting habitats (Table 4.4.1.6.2-1).

Summary. Alternative 1 is anticipated to result in a continued minor level of effect on marine and coastal bird habitats because of annual destruction of marine and coastal bird habitats for community and industrial development.

4.4.1.7.3.2.8 Anticipated Level of Effect from Seismic-Airgun Noise. Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is done during the winter when marine and coastal birds are absent. Offshore surveys on submerged State lands typically are conducted by vessels during the open-water period.

The State of Alaska is considering leasing additional State-owned tide- and submerged lands lying between the Canadian border and Point Barrow (ADNR, 2008). Oil and gas development in nearshore waters under State jurisdiction could add to seismic disturbance experienced by marine and coastal birds in the Beaufort Sea region. Important mitigation measures that the State likely would impose to protect certain marine and coastal birds are listed in Section 4.4.1.6.2.2.

There are existing leases in the Beaufort Sea OCS, and it is reasonable to expect leaseholders and others to investigate the potential for oil or gas production in the future. Shell Offshore, Inc., for example, likely will continue to complete seismic surveys in advance of exploration drilling on certain existing Beaufort Sea leases (USDOJ, MMS, 2007b). Similar seismic activities are anticipated for other planned development, such as the Liberty Project (USDOJ, MMS, 2008). Additional seismic or exploration work would likely be proposed in the future for other existing leases in the Beaufort Sea. Exploratory and delineation drilling, seismic work, and related support activities from existing leases and surrounding waters would occur primarily during the ice-free, open-water period.

While there likely would be a continuation of existing levels of seismic activity and increased exploration drilling in the Beaufort Sea, mitigation measures would be required on exploration and development

activities to avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. No injuries to marine and coastal birds are anticipated from seismic activities.

Summary. Seismic activity under Alternative 1 is anticipated to result in a negligible level of effect on marine and coastal birds.

4.4.1.7.3.2.9. Anticipated Level of Effect from Changes in the Physical Environment.

Section 4.4.1.6.2.1.9 briefly described likely ongoing effects from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. These changes in the physical environment may affect marine and coastal bird populations.

Some of these expected changes could benefit coastal birds using habitats on the ACP, at least initially. An expansion of more productive wetland habitats could provide additional nesting sites for several species and boost the abundance and distribution of aquatic plants and insects important to many bird species. These benefits to birds would be expected to decline over time, as wetlands and lakes disappear.

Climatic change could have stochastic or habitat effects on many species that may surpass the impacts of other activities. As previously stated, however, the implications of climate change on marine and coastal birds are impossible to predict with any precision. For purposes of analysis, we assume most of the obvious trends are anticipated to continue. We consider these trends in determining the effects of the alternatives.

Changes in the physical environment are believed to result from climate changes superimposed on the vagaries of regional weather patterns. These long-term trends are outside the influence of authorized actions.

Summary. Continued climate change is anticipated to result in a major level of effect on marine and coastal birds.

4.4.1.7.4. Species-Specific Level of Effect.

Puffins. Puffins are less abundant in the Beaufort Sea compared to the Chukchi Sea. The tufted puffin is an obligate cliff nester, and there are few cliffs along the Beaufort Sea coast. Horned puffins can breed on suitable beach habitat on islands nearshore by digging burrows or hiding under large pieces of driftwood or debris. Horned puffins are expected to continue to expand eastward from the Chukchi Sea into nesting colonies along the Beaufort Sea coast. Climate change (increased storm waves/tidal surge) could erode burrow sites or reduce driftwood abundance on barrier islands of the Beaufort Sea. Ongoing disturbances to puffins from unrestricted vessel and low-level aircraft traffic in nearshore areas would continue along the Beaufort Sea coast.

Mitigation measures imposed on future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to puffins in the Beaufort Sea.

This level of disturbance is anticipated to result in a negligible level of effect to puffins.

Short-Tailed Shearwaters and Auklets. These seabirds are more abundant in the Chukchi Sea compared to the Beaufort Sea. Large-scale collision events involving crested auklets and high-intensity lights on commercial fishing vessels have been documented in other ocean regions. Collisions may occur with an increasing number of vessels that could be operating in the Beaufort Sea. As few collisions from the Beaufort Sea have been documented to date, it appears that this is not a large source of mortality.

Large numbers of shearwaters or auklets could be harmed by collisions with seismic vessels and exploration and development structures, but mitigation measures imposed on future exploration and development activities would avoid or minimize adverse effects to shearwaters and auklets in the Beaufort Sea.

This level of disturbance or mortality is anticipated to result in a negligible level of effect to short-tailed shearwaters and auklets.

Black Guillemot. These birds usually are closely associated with the ice edge. As the ice edge has been receding away from breeding colonies, guillemot breeding success has fluctuated due to vagaries in ice location/duration and direct competition with horned puffins. It is likely that continued climate change (long-term decreases in sea ice distribution/abundance) will negatively affect black guillemot populations in the Beaufort Sea in the foreseeable future regardless of other efforts to minimize sources of disturbance or mortality.

Mitigation measures imposed on exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to black guillemots in the Beaufort Sea.

The single most important factor influencing black guillemots in the Beaufort Sea is the distribution and abundance of sea ice. Vessel or aircraft disturbance could result in a minor level of effect on black guillemots. This species, however, likely will experience a major level of effect from climate change, because ongoing trends are anticipated to continue.

Loons. Loons using nearshore areas of the Beaufort Sea could be affected by disturbance from vessels and low-flying aircraft. Loons, in particular the yellow-billed loon, are at particular risk due to their low numbers and low reproductive rate. The yellow-billed loon is highly vulnerable to environmental change compared to most waterfowl. Patchy distributions and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations, such as disturbance and habitat alterations, than more abundant and widely distributed species that are able to exploit a greater diversity of habitats (Hunter, 1996).

The yellow-billed loon is little studied, and basic biological information (such as the seasonal distribution of immature and nonbreeding yellow-billed loons) is unknown. Additional research could improve our understanding of the vulnerabilities of the yellow-billed and other loons using nearshore areas of the Beaufort Sea.

In April 2008, the Center for Biological Diversity (CBD) announced it had reached a tentative agreement with the FWS to make a decision by mid-February 2009, regarding whether or not to propose the species for listing as a threatened or endangered species under the ESA. At the time of the CBD press release, the judge in the lawsuit had not ruled on the proposed settlement. If the FWS proposes to list the species in February 2009, it would take at least several more months to complete the listing or decline the listing proposal. While the species is in a proposed status, Federal Agencies would have to conference with the FWS only for those projects that could jeopardize the continued existence of the yellow-billed loon.

Mitigation measures imposed on any future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to loons, especially yellow-billed loons.

Long-Tailed Duck. Long-tailed ducks are prone to collisions with structures and vessels. Vessels conducting seismic surveys on State leases could pose a threat to long-tailed ducks, especially if the vessels were using high-intensity work lights while operating during darkness or inclement weather. The

risk of collisions with seismic-survey vessels would be highest when these vessels are in the area of the 20-m isobath during fall migration. Long-tailed ducks are uncommon further offshore.

Disturbance impacts to long-tailed ducks from vessels and low-flying aircraft associated with seismic-survey and exploration drilling activities on State leases could continue to have a minor level of effect on long-tailed ducks unless specific mitigation measures are implemented.

Potential disturbance impacts to long-tailed ducks from seismic surveys on existing leases and surrounding waters in the Beaufort Sea would be low during the postbreeding molting period, because most birds are concentrated in coastal lagoons generally outside of the OCS. Mitigation measures imposed on future exploration and development activities would avoid or minimize adverse effects to long-tailed ducks in the Beaufort Sea to a minor level of effect.

Common Eider. Most common eiders follow the 20-m isobath, which predominantly is in nearshore waters at the outer margin of the OCS (Figure 3.3.5.5). Seismic vessels operating on State leases could pose a threat, if the vessels were using high-intensity lights in migratory paths in darkness or inclement weather. The risk of collisions with seismic-survey vessels would be highest when these vessels are in the area of the 20-m isobath during fall migration.

Potential disturbance impacts to common eiders from seismic surveys on existing leases and surrounding waters in the Beaufort Sea would be low during the migration period, because most birds are concentrated in nearshore coastal areas, generally at the outer edge of the OCS. Similarly, the risk of collisions with drillships would be lower, because many existing leases are farther offshore than known migration pathways for common eiders. The risk of collisions would decrease markedly, if vessels were located well outside typical migration pathways. Mitigation measures imposed on any future exploration and development activities avoid or minimize adverse effects to common eiders in the Beaufort Sea to a minor level of effect.

King Eider. Impacts to king eiders would be similar to common eiders, except that king eiders molt at locations in the Bering Sea. Migration distances from shore are similar, so the collision risks would be the same as for common eiders. King eiders tend to occur farther offshore in greater concentrations of broken ice.

As with common eiders, mitigation measures imposed on any future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse impacts to king eiders in the Beaufort Sea and a minor level of effect is anticipated.

Black-Legged Kittiwake. Kittiwakes in pelagic offshore waters are anticipated to experience a negligible level of effect from existing and future activities in the Beaufort Sea.

Mitigation measures imposed on any future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to black-legged kittiwakes in the Beaufort Sea to a negligible level of effect.

Pacific Brant. Pacific brant could continue to be affected by disturbance from low-flying aircraft, but this activity does not appear to consistently affect brant populations. Predation by foxes can continue to reduce the net productivity of brant nesting colonies, but fox numbers appear to fluctuate and several years may go by without foxes depredating larger colonies.

Mitigation measures imposed on any future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse effects to Pacific brant in the Beaufort Sea and negligible level of effect is anticipated.

Phalaropes. Phalaropes are most abundant in the Beaufort Sea during the postnesting period in late summer and fall. Phalaropes use habitat within a few meters of shore as well as pelagic areas, where they forage on patchy concentrations of zooplankton. Phalaropes could be disturbed by vessels and low-flying aircraft in nearshore coastal areas.

Collisions with vessels or structures are a possibility. Lambert (1988) reported that red-necked phalaropes were attracted to lights on a ship in the Gulf of Guinea and reacted most strongly at night in inclement weather. There do not appear to be any other documented cases of collisions involving phalaropes, so the incidence of collisions may be either low or unreported.

Mitigation measures imposed on future exploration and development activities from existing leases would and surrounding waters avoid or minimize adverse impacts to phalaropes in the Beaufort Sea, and a negligible level of effect is anticipated.

Ice-Associated Gulls. Ross's gulls and ivory gulls breed outside the lease-sale areas. They are present in the proposed lease-sale area for a short period when migrating to overwintering locations. These gulls, particularly ivory gulls, are expected to continue to decline due to climate change-induced habitat changes outside the Beaufort Sea. These climate change effects are anticipated to result in a major level of effect on these species.

Other Gulls and Terns. Gulls likely would benefit from sources of unsecured human-use foods and garbage associated with communities and the oil/gas industry. As ground nesters, gulls are more apt to spread to areas where they are not limited by facilities for elevated nesting structures, such as are required by ravens. Gulls occur in large numbers at unnatural concentrations of food, such as bone piles from whale harvests near coastal villages.

Mitigation measures imposed on future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse impacts to other species of gulls and terns in the Beaufort Sea, and a negligible level of effect is anticipated.

Northern Fulmar. Most fulmars are present only in the Chukchi Sea but may stray into the Beaufort Sea for a few weeks at the end of summer. A negligible level of effect is anticipated.

Jaegers. Jaegers are present throughout the Beaufort Sea, but are not known to occur in high concentrations. A negligible level of effect is anticipated.

Other Waterfowl and Shorebirds. Impacts on many species of waterfowl and shorebirds are anticipated to be relatively low, but there are some key areas of vulnerability where they could be at risk of effects from exploration. There appear to be coastal sites along the Beaufort Sea where large numbers of migrating shorebirds concentrate. For example, the Colville River Delta hosts between 41,000 and 300,000 shorebirds between July 25 and September 5 (Andres, 1994; USDOJ, FWS, 2004a). The range of these numbers depends upon how long birds remain in the area before migrating (Andres, 1994; Powell, Taylor, and Lancot, 2005; Taylor et al., 2006). Results on bird tenure times from the Taylor et al. (2006) project may help clarify the anticipated range of shorebirds using the delta. At the present time, it appears that large numbers of shorebirds could be affected during this important post-breeding period by low-level aircraft traffic and other disturbances. These sites may become highly modified because of

changes in coastal morphology due to increased storm frequency, magnitude, and wave height, but this would be a more gradual process.

Mitigation measures imposed on any future exploration and development activities from existing leases and surrounding waters would avoid or minimize adverse impacts to shorebirds of the Beaufort Sea, and a negligible level of effect is anticipated.

Raptors/Ravens. Raptors and ravens may continue to extend their range and increase in abundance, if they continue to nest on community/development structures. These structures benefit raptors. Ravens also benefit from easy access to human-use foods and garbage, allowing them to overwinter in areas where they previously were unable to. These effects would have a net negative impact on other marine and coastal birds because of increased predation, particularly by ravens. Enforcement of NSB ordinances could help eliminate bird predator access to human-use foods or garbage and would not facilitate the continued increase in fox and raven distribution or abundance across the North Slope.

No adverse effects to raptors or raven populations are anticipated during exploration activities from existing leases and surrounding waters in the Beaufort Sea. While production is speculative until commercially developable discoveries are made, recent authorizations required mitigation measures to prevent the nesting of ravens and denning of foxes associated with production and transportation facilities (USDOJ, MMS, 2007a).

Overall, the expansion of raptors/ravens is anticipated to result in a continued minor level of effect on other marine and coastal birds.

4.4.1.8. Other Marine Mammals.

Summary. This section addresses those marine mammals not currently listed under the ESA that typically occur in the Alaskan Beaufort Sea. All marine mammals are protected by the MMPA. These marine mammals include ice seals (ribbon, ringed, bearded, and spotted seals); the Pacific walrus; toothed whales (beluga and killer whales, narwhal, and harbor porpoise); and baleen whales (minke and gray whales). Pacific walrus and all four of the ice seal species have been petitioned for listing under the ESA.

Ringed, Spotted, Ribbon, and Bearded Seals. Ringed and bearded seals are relatively common in the Beaufort Sea. Spotted and ribbon seals are less common. These ice seals are hunted by Alaskan Natives and are coexisting with numerous aircraft operations and an increasing volume of vessel traffic. Existing levels of oil and gas activities, including seismic surveys, continue to have negligible effects on ice seals; however, ongoing changes in the physical environment from climate change have the greatest potential to result in major effects on ice seals.

Pacific Walrus. Pacific walrus primarily inhabit the Chukchi and Bering seas, but walrus occur regularly in the Beaufort Sea as far east as Kaktovik. Exploration and development in the Arctic could impact walrus through disturbance, displacement, contamination of prey, or accidental fuel spills. Production activities may displace walrus from areas used for feeding and resting. Existing levels of oil and gas activities in the Beaufort Sea have a negligible level of effect on walrus. Pacific walrus may be increasingly impacted by changes in sea-ice cover. In recent years, walrus have been coming ashore in greater numbers as the sea ice retreats over the Continental Shelf, areas too deep for walrus to forage successfully. Continued declines in sea-ice extent may limit resting and calving habitat available to walrus, increase the importance of coastal haulouts, decrease available foraging habitat, and increase energetic expenditures as walrus are forced to swim farther between feeding and resting areas.

Continued declines in the spatial and temporal extent of sea ice may have a major level of effect on walrus.

Beluga Whale, Killer Whale, Narwhal, and Harbor Porpoise. Killer whales, narwhals, and harbor porpoises are infrequent visitors to the Beaufort Sea. Beluga whales are much more common with an estimated population of 32,000, but the population trend is unknown. Beluga whales are subject to subsistence harvest, and the harvest does not exceed the Potential Biological Removal (PBR). The annual harvest of about 186 belugas is expected to continue and is the largest known source of removal. Existing effects from various vessel and aircraft activity and Federal and State oil and gas industry activities, including seismic exploration, on existing Beaufort Sea leases may have minor effects to individual whales, but they are expected to have negligible effects on the species populations with ongoing monitoring and mitigation. Habitat changes from climate warming will continue to affect these species, but the consequences are not predictable at this time.

Minke Whale and Gray Whale. The minke whale does not regularly occur in the Beaufort Sea. Should isolated individuals or small groups occur in the Beaufort Sea, we anticipate the effects to be similar to effects noted for gray whales. This alternative is anticipated to result in a negligible level of effect to minke whales.

Existing effects of various vessel and aircraft activity and Federal and State oil and gas industry activities, including seismic exploration, on existing Beaufort Sea leases are anticipated, with ongoing monitoring and mitigation to result in a negligible level of effect to small numbers of gray whales that use the nearshore shelf habitats of the Beaufort Sea; however, ongoing changes in the physical environment from climate change are uncertain and may result in beneficial or adverse effects to gray whales and their habitat in the Beaufort Sea.

In Section 4.4.1.8.1, we describe the potential effects to these marine mammals from a variety of existing sources, including marine vessel and aircraft traffic and noise, collisions, petroleum spills, habitat loss, seismic noise, and environmental contaminants. We then describe some of the existing mitigation measures that would avoid or minimize some of these impacts (Section 4.4.1.8.2). We analyze the anticipated effects on marine mammals from this alternative (with mitigation in place) in Section 4.4.1.8.3.

The narwhal, killer whale, and the harbor porpoise are rare species in the Alaskan Beaufort Sea (Sections 3.3.6.2.1.2, 3.3.6.2.1.3, and 3.3.6.2.1.4, respectively) and are not analyzed separately in this section. If isolated individuals or small groups of these species occur in the Beaufort Sea, we anticipate the general effects to be similar to those described for these species in Section 4.5.1.8.3, but at a reduced level.

The minke whale occurs west of Barrow, in the Chukchi Sea, and does not regularly occur in the Beaufort Sea (Section 3.3.6.2.2.1) so this species is not analyzed separately in this section. If isolated individuals or small groups occur in the Beaufort Sea, we anticipate the effects to be similar to gray whales, but at a reduced level.

4.4.1.8.1. Potential Effects to Marine Mammals. The principal sources of potential adverse effects to marine mammals in the Beaufort and Chukchi seas include: (1) underwater noise; (2) vessel and aircraft disturbance; (3) subsistence; (4) habitat loss; (5) environmental contaminants; (6) petroleum spills; and (7) changes in the physical environment.

4.4.1.8.1.1. Potential Effects from Underwater Noise. If underwater noise causes disruption of important behaviors such as mating, nursing, or feeding, or if animals are frightened away from important

habitat over long periods of time, these impacts could affect the long-term survival of the population (Erbe and Farmer, 2000). Noise also can interfere with communication signals, environmental sounds that animals might use for orientation, and the ability to hear and locate predators and prey (Erbe and Farmer, 2000). Knowledge of absolute thresholds (i.e., absolute audiograms) is crucial for estimating acoustic impact (Erbe, 2002).

There are four sources of anthropogenic noise in the Alaskan Arctic: (1) vessel-traffic noise; (2) aircraft noise; (3) seismic-survey noise; and (4) exploration and production drilling noise.

4.4.1.8.1.1.1. Vessel Traffic and Noise. Current levels of vessel traffic in the Alaskan Arctic are unknown, but numerous sources report recent increases. According to the USCG (2007), the primary source of distress calls in the Arctic are stranded whale hunters. In addition to vessel traffic that supports local communities and the oil industry, traffic levels are changing as the open-water season begins earlier and ends later in the year. Shipping routes via the Northeast Passage have increased, as this route has remained open on a more predictable basis. The extended open-water season allows the shipping industry to save more than 4,000 mi in shipping costs by avoiding the Panama Canal, using the Northwest Passage instead.

Vessel traffic in the Alaskan Arctic generally occurs within 20 km of the coast and usually is associated with supply ships, barges fishing, hunting, cruise ships, seismic surveys, and icebreakers. No extensive maritime industry exists for transporting goods. Traffic in the Beaufort Sea at present is limited primarily to late spring, summer, and early autumn.

Noise produced from vessels generally is expected to be less in shallow waters (i.e., vessel noise returns to background levels by 10 km away from the vessel) and greater in deeper waters. Traffic noise up to 4,000 km away may contribute to background noise levels (Richardson et al., 1995b). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contribute to overall noise levels in some regions of the Beaufort Sea. Whaling boats (usually aluminum skiffs powered by outboard motors) also contribute noise during the fall whaling period in the Beaufort Sea. Fishing boats in coastal regions also contribute noise to the overall noise levels. Noise produced by these smaller boats typically is at a higher frequency (peaking *ca* 200–300 Hz) than somewhat larger boats (Richardson et al., 1995b).

Icebreakers may assist seismic-source vessels and other vessels in transit to and from locations during ice conditions and support drillship operations and would be typical during late fall ice conditions. Richardson et al. (1995a) reported that broadband (20–1000 Hz) received levels at 0.37 km for the icebreaking supply vessel the *Canmar Supplier* underway in open water was 130 dB and 144 dB when it was breaking ice. The increase in noise during icebreaking apparently is due to propeller cavitation. Richardson et al. (1995a) summarized that icebreaking noise from the *Robert Lemeur* pushing on ice was detectable more than 50 km away. We anticipate that an icebreaker would attend a drillship in the Beaufort Sea. If drillships are attended by icebreakers, as typically is the case during fall, the drillship noise frequently may be masked by icebreaker noise, which often is louder. Response distances would vary, depending on icebreaker activities and noise-propagation conditions.

Richardson et al. (1995a:Table 6.5) provided source levels at 1 m for icebreaker noise. For example, they note that noise levels from the M/S *Voima* in open water at 50-60% power had broadband-noise levels of 177 dB re 1 μ Pa-m, whereas the source level when icebreaking full astern was 190 dB re 1 μ Pa-m.

Response distances of whales to icebreakers are expected to vary, depending on the size, engine power, and mechanical characteristics of the icebreaker, vessel activities, noise-propagation conditions; the species, age and sex of individuals exposed; and the activities they are engaged in when exposed.

Richardson et al. (1995b), for example, concluded that exposure to a single playback of variable icebreaker-noise levels can cause statistically but probably not ‘biologically significant’ effects on movements and behavior of migrating bowhead whales in the lead system during the spring migration east of Point Barrow.

Ringed, Spotted, Ribbon, and Bearded Seals. Richardson (1995) found that vessel noise does not seem to strongly affect pinnipeds that are already in the water. Richardson went on to explain that seals on haulouts often respond more strongly to the presence of vessels, suggesting the limited data and responses of Phocid seals to other noisy human activities could mean that seals have a high tolerance to vessels and vessel noise. Reeves (1998) noted that some ringed seals have been killed by ice-breakers moving through fast-ice breeding areas and that the passing ice-breakers could have far reaching effects on the stability of large areas of sea ice however these mortalities are associated with actual icebreaking movements and not the associated noise. Negligible levels impacts should arise from increasing vessel noise in the Beaufort Sea analysis area.

Pacific Walrus. Vessel traffic could disturb walrus at sea, along the ice edge or within spring lead systems and may interrupt the movements or foraging of walrus by temporarily displacing some animals when vessels pass through an area. Such traffic is not likely to have more than a short-term (a few hours to a few days) effect on walrus movements or distributions; but the displacement of walrus could have a localized affect on the availability of these animals to subsistence hunters for that season. Icebreaker activity would physically alter some ice habitats. This could temporarily destroy some potential resting habitat in pack-ice areas, or provide access to additional areas by opening up new leads. Repeated disturbance from vessel traffic could have energetic costs, and has the potential to separate calves from their mothers. The level of impact would depend upon the amount of disturbance.

The reaction of walruses to vessel traffic appears to depend on vessel type, distance, speed, and previous exposure to disturbances. Weather and the length of time that the walrus have already been hauled out also affects the level of response. Brueggeman et al. (1991) reported that 81% of walruses encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walruses may be tolerant of ship activities and movements. However, ice-management operations are expected to have the greatest potential for disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Potential effects from prolonged or repeated disturbance include displacement from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water.

Beluga Whale. The ability of cetaceans to communicate, navigate, and echolocate can be compromised by underwater noise. Vessel generated noises are associated with oil and gas exploration and development, shipping, research, recreation, subsistence hunting, and military activities. These activities ensonify whale habitat and have the potential to interfere with whale behavior and their communications both by causing disturbance reactions to such noise or by masking whale communications. Masking is the obscuring of the perception stimulus, resulting from the presence of a stronger interfering stimulus in the same range (Richardson et al. 1995a,b). Because of the lack of data regarding the importance of natural sounds to marine mammals, the consequences of masking are unclear (Richardson et al. 1995b). Masking has not only the potential to interfere with whale communication, but also to reduce the area over which whales can effectively search for food (Bain and Dahlheim, as cited in Williams, Trites, and Bain, 2002). Exposure to noise of sufficiently high intensity causes a reduction in hearing sensitivity (an

upward shift in the threshold). This can be a temporary threshold shift (TTS), with recovery after minutes or hours, or a permanent threshold shift (PTS) with no recovery (Gordon et al. 2003, 1998).

Erbe (1997) reported the maximum sensitivity for beluga whales to lie between 20 to 80 kHz—the frequencies they use for echolocation. Richardson et al. (1995b) reported that beluga hearing extends at least as low as 40-75 Hz, but that sensitivity at these lower levels is poor. In contrast, because belugas and other odontocetes use high frequency sound for echolocation, their high-frequency hearing abilities are very good. Killer whales show upper frequency hearing limits near 120 kHz and belugas about 100 kHz (Richardson et al. 1995b). Belugas communicate using frequencies from 0.1-12 kHz (O’Corry-Crowe et al., 2002).

Belugas and other toothed whales seem to be most sensitive to frequencies near or above 10 kHz, and sensitivity to frequencies below 10 kHz declines rapidly with decrease in frequency (Cosens and Dueck, 1993). For belugas, detection of vessel noise below 5 kHz appears to be limited by their auditory threshold. Belugas and narwhals tend to react to sounds when they are just detectable, so their reaction zone is equivalent to their detection zones. Belugas apparently are unable to detect low frequencies beyond a few hundred meters from the source. However, reaction distances for belugas will be larger when industry noise contains high frequency components (Cosens and Dueck, 1993).

Belugas, at least in some locations, have an aversion to anthropogenic noise particularly outboard-powered boat traffic (Huntington et al., 1999; Huntington and Mymrin, 1996). While belugas may habituate to constant noises, they avoid variable anthropogenic noise (e.g., boats, helicopters). Belugas may be capable of habituation to considerable noise when it is not associated with hunting (Huntington et al., 1999).

Based on information provided in the discussion of impacts associated with vessel traffic, belugas react to the approach of vessels at great distances. Finley et al. (1990) noted belugas were aware of a ship’s approach at 80 km and showed strong avoidance reactions at ranges 35-50 km when received noise levels ranged from 94-195 dB re 1 μ Pa in the 20- to 1,000-Hz band. The researchers concluded that belugas were extraordinarily sensitive to vessel activity, and that masking by industrial noise could conceivably result in reduced navigational and foraging capabilities thereby leading to physiological stress and reduced fitness of populations. Late-summer distribution and fall-migration patterns, wintering areas, and areas particularly important for feeding have not been well identified (Suydam, Lowry, and Frost, 2005).

The critical issue, however, may not be the increased expenditure of energy by cetaceans to avoid ships, but rather the potential for ships and seismic vessels to cause a reduction in their overall energy acquisition, via the masking effects of noise, interruption of feeding activities, or replacement of feeding activity with ship-avoidance activities (Williams, Lusseau, and Hammond, 2006). Disruption of feeding activity could lead to a substantial decrease in energy intake for animals exposed to ship disturbance. In fact, the energetic consequences of reduced energy acquisition have the potential to be at least four to six times as great as the cost of avoidance behavior (Williams, Lusseau, and Hammond, 2006). In food-limited populations, this is one mechanism that could link short-term consequences of vessel traffic to long-term, population-level consequences (Williams, Lusseau, and Hammond, 2006). For example, increasing whales’ energetic costs or reducing their ability to acquire prey, if the effect is sufficiently strong, can change the demographic parameters that influence effective population size (Anthony and Blumstein, 2000).

Gray Whale. Vessel presence and noise can adversely affect cetaceans by noise and disturbance from the seismic vessel; seismic-noise sources for 2D and 3D surveys; drillships; and from related support ships, boats, and icebreakers. In addition, animals could be injured by very close proximity to airgun discharges, seismic ships, or boat noise or collision. From a behavioral perspective, increased

anthropogenic noise, including seismic-noise source, vessel noise, and noise from a variety of exploration drilling- and production-related activities, could interfere with communication among cetaceans, mask important natural and other gray whale sounds, or alter natural behaviors (i.e., displacement from migration routes or feeding areas; disruption of feeding, resting, or nursing). Behavioral impacts appear to be affected by gender and reproductive status, age, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the sound previously (e.g., Olesiuk et al., 1995; Richardson et al., 1995a; Kraus et al., 1997; NRC, 2003c, 2005). For example, cetacean females with calves show a heightened behavioral response to seismic noise (Henley and Ryback, 1995; McCauley et al., 2000). In other studies, animal reactions have been mixed during studies on the effects of seismic activity on feeding bowhead whales with some animals ceasing feeding and others continuing feeding (Fraker, Richardson, and Wursig, 1995; Richardson, Wells, and Wursig, 1985).

With their larger body and ear size and basilar membrane thickness-to-width ratio, are low-frequency hearing specialists, with an auditory range starting at 10 Hz and possibly moving as high as 30 kHz (Ketten, 1998). Erbe (2002), inferring from grey whale vocalizations, suggested they should be sensitive to frequencies between 20 Hz and 4.5k Hz, with best sensitivity around 20 Hz-1.2k Hz. Clicks are reported up to 10 kHz, with main energy between 1.4 and 4k Hz. The lowest response threshold reported was 82-95 dB at 800 Hz (Erbe 2002). By comparison, minke whales appear most sensitive to sound between 100 and 200 Hz, with good sensitivity extending from 60 Hz-2 kHz. High-frequency clicks were published in two studies, indicating some sensitivity between 4 and 7.5 kHz, up to 20 kHz (Erbe, 2002).

It has been reported that gray whales may display escape behavior toward boats in their breeding lagoons, particularly boats moving fast or erratically. Other studies have suggested gray whales habituate to whale-watching vessels and may even approach them. Whales showed no evident avoidance to underwater playback of outboard engine noise, but call rates and call structure changed with exposure to actual boats, perhaps due to reduce masking of calls (Richardson et al., 1995b).

4.4.1.8.1.1.2. Aircraft Noise. Various commercial passenger aircraft, recreational aircraft, research aircraft, and industrial aircraft (transport and monitoring) use occurs in coastal areas of the Beaufort Sea. There is no quantitative temporal or spatial accounting for these activities at this time. Furthermore, it is difficult or impossible to discern if reactions to aircraft are from underwater or surface noise or the presence of the aircraft near the animal, and some of the effects described here actually may be the result of the physical presence of aircraft (Section 4.4.1.8.1.2.2).

Most offshore Beaufort Sea aircraft traffic in support of OCS oil industry involves turbine helicopter straight-line flights for personnel transport and fixed-wing aircraft engaged in monitoring activities. An example of potential volume of traffic is indicated during a typical open-water period (June 16–October 31) in 2001, when there were approximately 989 roundtrip helicopter flights to Northstar Island (Richardson and Williams, 2002).

Underwater noise from aircraft is transient. According to Richardson et al. (1995a), the angle at which a line from the aircraft to the receiver intersects the waters surface is important. At angles greater than 13 degrees from the vertical, much of the incident noise is reflected and does not penetrate into the water. Therefore, strong underwater noises are most detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period that it passes overhead and is heard underwater. The helicopter noise measured underwater at depths of 3 and 18 m showed that noise consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor noise behind the aircraft; more noise pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Noise levels received underwater at 3 m from a Bell 212 flying overhead at 500 ft (152 m) ranged from 117-120 dB re 1 μ Pa in the 10–500-Hz band.

Underwater noise levels at 18 m from a Bell 212 flying overhead at 500 ft (152) m ranged from 112–116 dB re 1 μ Pa in the 10–500-Hz band.

Ringed, Spotted, Ribbon, and Bearded Seals. As detailed in Richardson et al. (1995a), reactions of ringed seals concealed in subnivean lairs (below snow on ice) varied with aircraft altitude and lateral distance (Kelly, Quakenbush, and Rose, 1986). Radiotelemetry indicated some seals left the ice when a helicopter was at an altitude 1,000 ft (<305 m) within a 1.25-mi (2-km) lateral distance. The noise in a ringed seal den is reduced by snow (Cummings Holliday and Bonnet 1983). However, counts of ringed seal calls in water suggests that seal abundance in one area subjected to low-flying aircraft and other disturbances was similar to that in less disturbed areas (Calvert and Stirling, 1985). The expected increase in aircraft noise is anticipated to have a negligible level of effects on ice seals in the Beaufort Sea analysis area.

Pacific Walrus. Air traffic can disturb hauled-out walrus, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing walrus hauled out on the ice, or at coastal haul outs. Aircraft disturbance of hauled out walrus may result in injury or death, particularly to young walrus calves. Although air-traffic disturbance would be very brief, the effect on individual walrus calves could be severe, if the calves were injured or separated from their mothers. As walrus spend more time ashore due to receding ice, the potential for disturbances to cause stampedes increases as well. Increases in physiological stress of adult or juveniles may reduce fitness and have implications for productivity and survivorship.

Walrus will flee haulout locations in response to disturbance from aircraft and ship traffic, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances, and walrus in the water are thought to be more tolerant to disturbance stimuli than those hauled out. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea-ice habitats have reported little reaction to aircraft above 2,500 ft. However, walrus hauled out on shore respond more readily to stimuli, including small aircraft above 2500 feet (762 m) and commercial jets overhead. Walrus at coastal haulouts are particularly vulnerable to injuries during stampedes, and will respond readily to aircraft noise long before the aircraft is in sight. We further address the effects of air traffic under Vessel and Aircraft Disturbances, Section 4.4.1.8.1.2.

Beluga Whale. The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on beluga whales exists in areas where they are aggregated, especially if such concentrations contain large numbers of cow/calf pairs. Observations of belugas reveal that spring-migrating beluga whales appear to be more responsive to aircraft overflights than other cetaceans. While belugas may be unlikely to react significantly to occasional single passes by aircraft at altitudes >150 m ASL, turbine-powered helicopter passes at about 250 m (820 ft) lateral distance from belugas and at altitudes up to 460 m ASL (1,500 ft) and Twin Otter passes at altitudes about 182 m (600 ft) ASL and at lateral distances about 250 m (820 ft) generate pronounced reactions (e.g., vigorous swimming, abrupt dives, or tail thrashing) from belugas.

Richardson et al. (1995a) opportunistically observed the effects of helicopter overflights on migrating belugas near Point Barrow during 1989-1994. Observations revealed that spring-migrating beluga whales appeared more responsive to aircraft overflights than other cetaceans. Belugas frequently responded to close approaches by a turbine-powered helicopter. Apparent reactions were observed during 31% of overflights. Whales reacted by diving, veering away, or showing other changes in behavior. The authors noted that during overflights, reactions occurred exclusively when the helicopter passed at ~250-m (820-ft) lateral distance from the whales, and at altitudes up to 460 m above sea level (ASL) (1,500 ft).

However, most belugas observed showed no obvious reaction to single passes at altitudes >150 m ASL. Those belugas maintained their headings and continued respiring at the surface while the helicopter operated nearby (Richardson et al., 1995a). The authors noted that the behavioral reactions of belugas were brief and presumably not of lasting significance, and that there was no objective way to measure the biological significance of the behavioral reactions observed.

Richardson et al. (1995a) observed beluga groups reacting overtly to aircraft overflights. Of 760 groups observed, 24 groups reacted overtly. Most reactions occurred when the aircraft (Twin Otter) was at altitudes about 182 m (600 ft) ASL and at lateral distances about 250 m (820 ft). The authors noted that direct overflights generated the most pronounced reactions (e.g., vigorous swimming, abrupt dives, or tail thrashing); however, aircraft to whale distances constituting “direct overflights” were not given. In a few cases, belugas responded to direct overflights by turning directly away from the aircraft, but in others, belugas responded only by looking up at the aircraft (Richardson et al., 1995a).

While overt behavioral reaction of toothed whales to a single low-flying helicopter or fixed-winged aircraft likely would be temporary (Richardson et al., 1995a), most “fleeing” reactions in mammals are accompanied by endocrine changes that, depending on the frequency and intensity of exposure and other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health.

Gray Whale. Malme et al. (1984) recorded gray whale response to the underwater playback of a Bell 212 helicopter. Broadband noise eliciting avoidance reactions by 10, 50, and 90% of the whales were 115, 120, and >127 dB re 1 μ Pa. Migrating whales reacted with abrupt turns and/or dives when subjected to a Bell 212 helicopter overflights at altitudes <250 m, but no overt reactions were observed when flights were >425 m (Richardson et al. 1995b). Whales changed course significantly and slowed in response to simulated passes.

4.4.1.8.1.1.3. Seismic-Survey Noise. Seismic surveys are used by oil and gas companies to assess the composition of relief of the seafloor. Open-water seismic exploration produces underwater noise from airgun arrays. This section focuses on the effects of seismic airgun noise as a separate impact source from regular vessel noise (Section 4.4.1.8.1.1.1) or the physical presence of the seismic or support vessels (Section 4.4.1.8.1.2). Sections 4.4.1.6.1.1.1.2 through 13 describe the potential effects of noise on cetaceans. This information is incorporated by reference as it directly applies to cetaceans.

Ringed, Spotted, Ribbon, and Bearded Seals. Ice seals use the acoustic properties of seawater to aid in navigation, social communication, and possibly predator avoidance. Most ice seals spend >80% of their time submerged in the water (Gordon et al., 2004); consequently, they will be exposed to noise from seismic surveys. Few studies of the reactions of ice seals to noise from open-water exploration have been published. Temporary threshold shift (TTS) values for ice seals exposed to brief pulses (either single or multiple) of underwater noise have not been measured.

Ice seals have good low-frequency hearing; thus, it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as from seismic surveys (Gordon et al., 2004). Masking of biologically significant sounds by anthropogenic noise is equivalent to a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individuals or populations of marine mammals. However, the consequences might be more serious in areas where many surveys are occurring simultaneously. Underwater audiograms for ice seals suggest that they have very little hearing sensitivity below 1 kHz; they can hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al., 1995a). While seismic surveys can contain energy up to 1 kHz, most of the emitted energy is <200

Hz. There is considerable variability in the vocalizations of seals, and many of the arctic species vocalize underwater in association with territorial and mating behaviors.

Reported seal responses to seismic surveys have been variable and often contradictory, although they do suggest that pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays (Richardson, 2000). However, Brueggeman et al. (1991) reported that 96% of the seals they encountered during seismic operations in the Beaufort Sea were encountered during nondata-acquisition activities, suggesting avoidance of active data-acquisition operations. Kelly, Quakenbush, and Rose (1986) reported that seals in the Alaska Chukchi Sea abandoned subnivean lairs and breathing holes that were within 150 m of seismic lines significantly more often (29.2% vs. 10.0%) than those at greater distances. Miller and Davis (2002) reported that on average, seals sighted during active seismic periods in the Beaufort Sea were significantly farther from the vessel (210 m) than those sighted during periods without airgun operations (150 m). At the 210-m distance, seals would have been exposed to noise levels of about 190 dB re 1 μ Pa (rms). Sighting rates of ringed seals from another seismic vessel in the Beaufort Sea showed no difference between periods with the full array, partial array, or no guns firing (Harris, Miller, and Richardson, 2001). Mean distances to seals sighted did increase during full array operations, however, suggesting some local avoidance at levels between 190 and 200 dB rms. By contrast, telemetry work by Thompson et al. (1998, as cited in Gordon et al., 2004) suggests that avoidance and behavioral reactions to small airgun sources may be more dramatic than ship-based visual observations indicate. Instrumented gray seals (*Halichoreus grypus*) and harbor seals exhibited strong avoidance behavior of small airguns, swimming rapidly away from the seismic source. Many ceased feeding and some hauled out, possibly to avoid the noise. The behavior of most of the seals seemed to return to normal within 2 hours of the seismic array falling silent. The authors suggest that responses to more powerful commercial arrays might be expected to be more dramatic and occur at greater ranges.

It is uncertain how seismic surveys potentially might impact seal-food resources in the immediate vicinity of the survey. As previously discussed in the seismic-survey PEA (USDOJ, MMS, 2006a), direct and adverse impacts affecting some prey species (i.e., some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years). If seismic surveys cause seal prey to become less accessible, either because they move out of an area or become more difficult to catch, then seal distributions and feeding rates are likely to be affected. Newly weaned seal pups may be particularly vulnerable to reduced feeding rates (Gordon et al., 2004) and, thus, may be disproportionately affected by seismic surveys. This is particularly pertinent considering that most seal pups are weaned in June, just prior to the open-water seismic-survey season. Conversely, damaged or disoriented prey could attract ice seals to seismic-survey areas, providing short-term feeding opportunities but increased levels of noise exposure (Gordon et al., 2004).

There is no specific evidence that exposure to pulses of airgun noise can cause PTS to the hearing of any marine mammal, even with large arrays of airguns. Direct impacts causing injury (Level A) from seismic surveys likely would occur if animals entered the 190-dB zone immediately surrounding the noise source. A marine mammal within a radius of 100 m around a typical array of operating airguns might be exposed to a few seismic pulses with levels >205 dB, and possibly more pulses if the animals moved with the seismic vessel. Although it is unlikely that airgun operations during most seismic surveys would cause PTS in marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals. Section 3.2.7 describes more in-depth details on sound/noise and acoustics in the Alaskan Chukchi and Beaufort seas. Negligible levels of effects are expected to result from current and future seismic activity in the proposed action area.

Pacific Walrus. Disturbances caused by vessel and air traffic associated with seismic activities may cause walrus groups to abandon land or ice haulouts. Severe disturbance events could result in trampling

injuries or cow-calf separations, both of which are potentially fatal. Seismic surveys would be unlikely to have impacts on the availability of walrus prey due to the sedentary nature of their prey sources (primarily bivalves and other benthic marine invertebrates).

Seismic operations are expected to create substantially more noise than general vessel and icebreaker traffic; however, there is little data available to evaluate the potential responses of walrus to seismic operations. Marine mammal-monitoring programs report that most walrus flee the area, while others (<4%) seem to be attracted to the seismic vessel (Brueggeman et al., 1991).

Walrus produce a variety of sounds (grunts, rasps, clicks) that range in frequency from 0.1-10 Hz (Richardson et al., 1995a). Because vocalizations associated with breeding behavior occur during the winter mating season, summertime seismic-survey activities are not expected to affect walrus breeding behavior. Walrus might be impacted by vessel and aircraft traffic associated with seismic surveys. For example, walrus hunters and researchers have noted that walrus tend to react to the presence of humans and machines at greater distances from upwind approaches than from downwind approaches, suggesting that odor also may be a stimulus for a flight response.

Based on previous monitoring efforts in the Chukchi Sea, exploration activities (seismic and, particularly, exploratory drilling) are expected to result in the take (Level B harassment) of up to several thousand walrus (Garlich-Miller, 2006, pers. commun.). The level of take in the Beaufort Sea is expected to be much lower. The potential for direct impacts causing injury (Level A) from seismic surveys would be most likely if individuals entered a 180-dB zone immediately surrounding the high-energy noise source. Although the hearing sensitivity of walrus is poorly known, source levels are thought to be high enough to cause temporary hearing loss in other species of pinnipeds. Therefore, it is possible that walrus within a 180-decibel (dB re 1 μ Pa) noise zone around seismic activities (industry standard) could suffer temporary shifts in hearing threshold. Direct impacts potentially causing injury (Level A) from seismic surveys also could occur if walrus hauled out on icefloes stampede into the water due to the approach of seismic vessels. Calves and young animals at the perimeter of these haulouts are particularly vulnerable to trampling injuries and to being separated from their mothers, which could prove fatal.

Walrus do not typically frequent water depths >200 m, which may exclude them from some survey areas. Most seismic surveys will occur in areas of open water, where walrus densities are expected to be relatively low, and monitoring requirements and mitigation measures are expected to minimize interactions with large aggregations of walrus. Because seismic operations likely would not be concentrated in any one area for extended periods, any impacts to walrus would be relatively short in duration and would have a negligible overall impact on the Pacific walrus population.

Beluga Whale. Activities noted in Sections 4.4.1.8.2.1 and 4.4.1.8.2.2 may have a noise-component potential that potentially could affect beluga whales. One of the greatest concerns associated with the impacts of oil and gas exploration and development on toothed whales has to do with potential impacts of noise on their ability to function normally, and on their health.

Overall, little research has been done to study the effects of seismic activity and related vessel and air traffic, on the behavior of toothed whales other than the sperm whale. However, a number of studies are useful in drawing conclusions on potential impacts. Morton and Symonds (2002) found in a 15-year study of killer whales in Johnstone Strait and Broughton Archipelago that killer whale presence was significantly lower during a 7-year period when acoustic-harassment devices (10 kHz devices with source levels of 194 dB re: 1 μ Pa at 1 m) were installed in the area, and the number of whales returned to baseline estimates when the noise source was removed. The control population of killer whales included in this study did not experience changes in individuals present over that same time period. Kraus et al.

(1997) found acoustic alarms operating at 10 kHz with a source level of 132 dB re 1 μ Pa at 1 m were an effective deterrent for harbor porpoises.

Hearing thresholds for toothed whales are highly species-specific. The high range of hearing sensitivity falls within 80–150 kHz (Richardson et al., 1995a), with the greatest sensitivity to sounds above 10 kHz (USDOJ, MMS, 2004). Killer whales are most sensitive at 20 kHz (Szymanski et al., 1999) with an upper frequency limit near 120 kHz (Bain, Kriete, and Dahlheim, 1993). Harbor porpoise hearing ranges from 1 kHz to over 100 kHz (Richardson et al., 1995a). Beluga whales appear to hear sounds from as low as 40–75 Hz, although their sensitivity at these low frequencies is considered poor, to over 100 kHz (Richardson et al., 1995a). The sensitivity of toothed whales to high-frequency sounds is attributed to their use of high-frequency sound pulses in echolocation and moderately high-frequency calls for communication.

Although most seismic-survey noise is concentrated below the 1-kHz level, measurements of airguns at sea have shown that there is some level of significant seismic energy even within the higher frequency levels (Goold and Fish, 1998). Therefore, although toothed whales, such as the beluga and killer whale and the harbor porpoise, specialize in hearing ranges generally outside of the majority of seismic-survey impulse noise, there still is the potential for noise from these surveys to fall within their acoustic sensitivity.

Belugas have poor hearing thresholds at frequencies below 200 Hz, where most of the energy from airgun arrays is concentrated. Beluga hearing threshold at these frequencies (as measured in a captive situation), is 125 dB re 1 micro Pa or more depending on frequency (Johnson, McManus, and Skaar., 1989). Although not expected to be significantly affected by the noise, given the high source levels of seismic pulses, airgun noise sometimes may be audible to beluga at distances of 100 km (62.1 mi) (Richardson and Wursig, 1997).

Knowledge of absolute thresholds (i.e., absolute audiograms) is crucial for estimating acoustic impact (Erbe, 2002). While such audiograms are lacking for white whales, Schlundt et al. (2000) recorded behavioral reaction of two white whales before and immediately after exposure to intense 1-s tones at 0.4, 3, 10, 20, and 75 kHz; white whales displayed altered behavior at 180–196 dB *re*: 1 mPa and above. At the conclusion of the study all thresholds were at baseline values. The authors concluded that the data confirmed that cetaceans are susceptible to TTS and that small levels of TTS may be fully recovered (Schlundt et al., 2000).

Beluga whales can be found in large aggregations in some areas of the Beaufort during summer, when they are located further offshore and associated with deeper slope water. Additional analysis must then be considered on how seismic activity may affect these concentrations of whales, especially when they are engaged in important biological behaviors such as feeding. Such analysis was done in a recent programmatic environmental assessment for 2006 exploration seismic surveying (USDOJ, MMS, 2006a).

The potential effects on prey species need to be considered in any evaluation of the effects of seismic surveys on cetaceans (IWC, 2006). It is uncertain about how seismic surveys might affect beluga food resources (e.g., cod) in the program area. As previously discussed in USDOJ, MMS (2006a:Section III.F.1), direct and adverse impacts affecting some prey species (i.e., some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning-habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years).

Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson et al., 1995a,b). Odontocetes are more likely to be harmed by high-frequency noise than baleen whales. There have been no documented instances of deaths, physical injuries, or auditory (i.e., temporary or permanent threshold shifts or other physiological) effects on toothed whales from seismic-

survey activity. Despite this, MMS recognizes that it may be difficult to document injury or harm, and that the potential for injury still may exist, particularly if individuals entered the 180-dB zone immediately surrounding the high-energy source or are struck by seismic vessels or support ships (USDOI, MMS, 2004).

Gray Whales. The seismic-survey PEA outlines the potential effects of noise and disturbance that can be expected from marine mammals, with a particular focus on cetaceans (USDOI, MMS, 2006a:Sections III.F.3.f(3), III.F.3.f(5), III.F.3.f(6), and III.F.3.f(8)). In addition, USDOI, MMS (2004) contains information on potential seismic-survey impacts to marine mammals in the Gulf of Mexico and is considered in the following analysis. The potential effects on prey species also need to be considered in any evaluation of the effects of seismic surveys on cetaceans (IWC, 2006).

Cetaceans could be adversely affected by noise from the seismic-noise source during 2D/3D seismic surveys, which can occur during prelease exploration, postlease exploration, development, and production phases of petroleum development. In addition, animals could be injured by very close proximity to airgun discharges. From a behavioral perspective, increased anthropogenic noise could interfere with communication among cetaceans, mask important natural and other gray whale sounds, or alter natural behaviors (i.e., displacement from migration routes or feeding areas, disruption of feeding or nursing). Behavioral impacts appear to be affected by gender and reproductive status, age, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the noise previously (e.g., Olesiuk et al., 1995; Richardson et al., 1995a; Kraus et al., 1997; NRC, 2003c, 2005). For example, cetacean females with calves show a heightened behavioral response to seismic noise (Henley and Ryback, 1995; McCauley et al., 2000). In other studies, animal reactions have been mixed during studies on the effects of seismic activity on feeding bowhead whales with some animals ceasing feeding and others continuing feeding (Fraker, Richardson, and Wursig, 1995; Richardson, Wells, and Wursig, 1985).

Gray whales, with their larger body and ear size and basilar membrane thickness-to-width ratio, are low-frequency hearing specialists, with an auditory range starting at 10 Hz and possibly moving as high as 30 kHz (Ketten, 1998). The most sensitive range appears to occur below 1 KHz. Given that seismic surveys produce noises in the frequency range used by baleen whales, including minke and gray whales, potential impacts to these species are considered greater than would occur with toothed whales.

Given the greater potential for anthropogenic-noise impacts on baleen whales, more research has been done to focus on potential effects on baleen whales than with toothed whales (although data still is considered limited). As with toothed whales, there have been no documented instances of deaths, physical injuries, or auditory (temporary or permanent threshold shifts or other physiological) effects from seismic surveys (USDOI, MMS, 2004). Although no documented injuries have occurred, MMS considers there to still be a potential for injury to marine mammals from seismic activities. However, the mitigation measures are designed to avoid Level A Harassment (potential to injure) and maintain any takes of marine mammals at or below Level B Harassment (potential to disturb).

Baleen whales also are subject to behavioral disturbance from the presence of anthropogenic noise. Overall, studies of gray, bowhead, and humpback whales have shown that received levels of impulses in the 160-170 dB re 1 μ Pa rms range appear to cause avoidance behavior in a significant portion of the animals exposed. Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Malme et al. (1986) studied the responses of feeding eastern Pacific gray whales to pulses from a single 100-in³ airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μ Pa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB.

Malme et al. (1986) estimated that an average pressure level of 173 dB occurred at a range of 2.6-2.8 km (1.4-1.5 nmi) from an airgun array with a source level of 250 dB (0-pk) in the northern Bering Sea. These findings generally were consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast. Malme and Miles (1985) concluded that, during migration, changes in swimming pattern occurred for received levels of about 160 dB re 1 μ Pa and higher, on an approximate rms basis. The 50% probability of avoidance was estimated to occur at a CPA (closest point of approach) distance of 2.5 km (1.3 nmi) from a 4,000-in³ array operating off central California. This would occur at an average received sound level of about 170 dB (rms). Some slight behavioral changes were noted at received sound levels of 140 to 160 dB (rms). However, these slight behavioral changes at levels below 160 dB may have been more relevant to the location of the noise source as the seismic array was placed in the middle of the gray whale migratory pathway. In Würsig et al. (1999), observations of gray whales near Sakhalin Island found no indication that western gray whales exposed to seismic noise were displaced from these feeding grounds in 1999 and 2001. However, there were indications of subtle behavioral effects and, in 2001, whales shifted their distribution away from a region where geophysical seismic surveys were being conducted (Johnson 2002; Weller et al. 2003b).

Currently, gray whales are believed to congregate along offshore shoals in the northern Bering and Chukchi seas for feeding during the summer months. Larger aggregations of feeding whales have been reported at these shoals. It is likely that shallow coastal and offshore-shoal areas provide habitat rich in gray whale prey, and their association and congregation in larger numbers with offshore shoals in the northern Chukchi Sea may indicate that these are important feeding areas for the expanding population (Moore and DeMaster, 1997). Because gray whales typically have shown documented disturbance reactions at levels at or above 160 dB, the effects of seismic surveys at these feeding sites also must be considered. Without appropriate mitigation, the potential exists for seismic activities to displace whales from these areas. However, given the mitigation measures (and any imposed under the MMPA authorization process), seismic activity at these feeding areas likely would result in adverse but not significant impacts to gray whales.

No studies are available specific to the effects of seismic-survey noise on minke whales, but the potential for impacts would be considered within the range of other baleen whales. Also, no known long-term impacts have been documented on gray and minke whale behavior as a result of seismic activity. However, mitigation and monitoring measures outlined in Section 2.2 of this document are considered to: (1) prevent Level A Harassment (injury); (2) lessen the potential for takes by Level B Harassment (disturbance); and (3) by limiting the potential for short-term harassment, ultimately avoid the potential for long-term, population-level effects.

There is a lack of studies of the auditory sensitivity of baleen whales. Most studies report on whale reaction to anthropogenic noises. The most sensitive range appears to occur below 1 KHz. Given that seismic surveys produce noises in the frequency range used by baleen whales, including minke and gray whales, potential impacts to these species are considered greater than would occur with toothed whales. Given the greater potential for anthropogenic-noise impacts on baleen whales, more research has been done to focus on potential effects on baleen whales than with toothed whales (although data are still considered limited). As with toothed whales, there have been no documented instances of deaths, physical injuries, or auditory (temporary or permanent threshold shifts or other physiological) effects from seismic surveys (USDOI, MMS, 2004). Although no documented injuries have occurred, MMS considers there to still be a potential for injury to marine mammals from seismic activities. However, the mitigation measures are designed to avoid Level A Harassment (potential to injure) and maintain any takes of marine mammals at or below Level B Harassment (potential to disturb).

Overall, studies of gray, bowhead, and humpback whales have shown that received levels of impulses in the 160-170 dB re 1 μ Pa rms range appear to cause avoidance behavior in a significant portion of the

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Malme et al. (1984) observed migrating gray whale response to airgun firing. Whales slowed and turned away and some whales moved to areas topographically shielded from the noise. Received levels for probabilities of avoidance for 10%, 50% and 90% of the animals were 164, 170, and 180 dB re 1 m Pa at 3.6, 2.5, and 1.2 km, respectively.

4.4.1.8.1.1.4. Exploration and Production Drilling Noise. Drilling on State and Federal leases is anticipated as leaseholders explore and develop potential productive oil and gas finds. Exploration drilling likely would involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible for exploration and development if production is pursued. If exploration drilling indicates that development and production is feasible, drilling would be expected to continue at a rate determined by the number of drill rigs available. For exploration drilling, up to two drillships are anticipated to be operating simultaneously in the Beaufort Sea. These may drill at more than a single location in a given year. While production of new fields in the Beaufort Sea OCS is not anticipated, exploration drilling can occur as lease holders delineate fields or otherwise determine the economic potential for producing that field. There are no drillships currently active in the Beaufort OCS; however, drilling has occurred there in the past.

Details on source- and received-sound levels for these drilling activities can be found in the recent MMS Biological Evaluation for the Arctic (USDOJ, MMS, 2006c) and Richardson et al. (1995a), and are considered in the analysis below.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects of offshore drilling on ringed seals in the Beaufort Sea were investigated in the past (Frost and Lowry 1988; Moulton et al. 2003). Frost and Lowry (1988) concluded that local ringed seal populations were less dense within a 2 nmi buffer of man-made islands and offshore wells that were being constructed in 1985-1987. Moulton et al. (2003) found ringed seal densities on the same locations to be higher in years 2000 and 2001 after a period of habituation. Conceptually it appears that ringed seals may be disturbed by drilling activities for a period of time, until the drilling and post-construction activity has been completed. Kelly, Burns, and Quakenbush (1988)

found that industrial noise caused 4% of ringed seals to abandon their lairs and breathing holes in undisturbed fast ice, while 13.5% abandoned their holes in disturbed fast ice areas. Eventually adult ringed seals seem to habituate to long-term effects of drilling activities. Consequently negligible levels of effects are believed to result from existing levels of exploration and production noises.

Pacific Walrus. The primary effects to walrus from exploration activity are habitat loss and disturbance. Noise and activity associated with drilling may displace some walruses from the immediate area. If drilling were to occur near a coastal haulout, the associated noise and disturbance has the potential to cause walrus to abandon the haulout. Walrus may also be displaced from the immediate area for the duration of the activity. The effects of this displacement are likely to be negligible in the Beaufort Sea, primarily because so few walrus inhabit the Beaufort Sea.

Beluga Whale. While belugas tend to avoid vessel noise, they are able, to a certain degree, to habituate to noise from constant (i.e., stationary) sources. Byers and Roberts (1995, as cited in Huntington et al., 1999) reported that belugas habituated to fixed platforms, but not to moving sources (i.e., helicopters and boats) in the Mackenzie Delta, Canada. Consistent with this observation are the findings of Mymrin et al. (1999) that belugas habituated to considerable port noises in the Anadyr River Chukotka, Russia. It seems that when noise is not allied with hunting, belugas are able to habituate to it (Huntington et al. 1999). Stationary noise sources such as stationary drillships, eliciting less dramatic reactions than moving sources is true for other cetaceans as well (Richardson and Malme, 1993). Cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event and this suggests that toothed whales will habituate to some noises that they learn are nonthreatening (Huntington et al., 1999).

A combination of noise sources of varying sound propagation characteristic could be operating simultaneously in the Beaufort Sea. The number and distribution of drilling operations, 2D/3D deep-penetration seismic surveys, high-resolution surveys, and associated support vessel and aircraft operations that may be operating concurrently in the Beaufort Sea would be temporally and spatially in a state of constant change and unpredictable. Collectively these combinations and dynamics of operations would create an ever-changing footprint of potential noise to which toothed whales could respond. Because this could occur, monitoring the dynamically changing area of avoidance and active and timely prevention of the development of such circumstances may require intensive open-water management of operations or temporary shutdowns, as necessary, to ensure the free movement of whales in regard to migration corridors, foraging area access and use, resting areas, and subsistence hunts.

We are aware that the extent of avoidance will vary both due to the actual noise-level radii around each noise source, the context in which it is received, and the motivation of the animal to stay within the area. It also may vary depending on cohort, and may be related to whether subsistence hunting has begun and/or is ongoing.

As time goes on, many of these activities can and probably will occur in both program areas in the same season and, in some cases, in closely adjacent areas. In 2006, 2D and 3D seismic surveys, icebreaker activity for transit, high-resolution surveys, and other support-vessel traffic were expected in the Beaufort Sea. Aerial surveys also were conducted. In 2007, exploration drilling, 2D and 3D seismic surveying, and high-resolution seismic surveys occurred in the Beaufort Sea. When these activities occur clumped in space and coincident in time and place with large numbers of toothed whales, large numbers of toothed whales could be adversely affected.

Data are sufficient to conclude that all response to future noise and disturbance is likely to vary with time of year; sex and reproductive status of individuals exposed; site (because of differences in noise

propagation and use by toothed whales); activity and the exact characteristics of that activity (e.g., drilling vs. seismic, airgun array, and configuration); the motivation of the animal to be in an area; and options for alternative routes, places to feed, rest, nurse, etc. While habituation to stationary sources may occur in time, toothed whales may exhibit avoidance of moving noise sources. We believe that it is unlikely that belugas will habituate to outboard powered boats because they are hunted annually and will maintain their aversion to such noise sources.

The potential total adverse effects of long-term added noise and disturbance on toothed whales are unknown. There has been no documented evidence that noise from previous OCS operations has served as an impediment to toothed whales. Because toothed whales have an aversion to loud noise they are less likely to suffer hearing loss from increased noise. However, future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise on belugas, including the potential for increased noise to cause physiological stress responses.

We acknowledge that we are not certain about the nature of long-term effects if multiple exploration seismic surveys and other noise and disturbance sources occurred for many years within an area that was frequently used by toothed whales. Concentrations of loud noise and disturbance activities during the open-water period have the potential to cause large numbers of belugas to avoid using areas while the noise producing activities continue. The strongest effects may be avoided or minimized through implementation of sufficient monitoring coupled with adaptive management to focus area, timing, and beluga presence-related mitigating measures where most needed.

However, belugas and other toothed whales need to hear the sometimes faint sounds of prey, predators, mates, or navigation cues. Faint acoustic cues from distant sources may be important to navigation and orientation (Erbe, 1997). Beluga whales are able to detect the return of their echolocation signals when they are only 1 dB above background (Turl et al., 1987, as cited in Marine Mammal Commission, 2007). Based on worst-case theoretical models, the ramming of icebreakers was predicted to mask beluga calls to ranges of 40 km and cause disturbance over ranges of 46 km (Erbe and Farmer, 2000). Based on modeling, Erbe and Farmer (2000) predicted that belugas would experience TTS after only 20 minutes of icebreaker noise at distances of 1-4 km.

Belugas tend to react to icebreaker noise nearly as soon as it becomes detectable (Erbe and Farmer, 2000). Finely et al. (1990), studying narwhal and beluga whale reaction to icebreaking activity and shipping in Lancaster Sound, Canada, determined that belugas were aware of a ship's approach at 80 km, and showed strong avoidance reactions at ranges 35-50 km when received noise levels ranged from 94-195 dB re 1 μ Pa in the 20- to 1,000-Hz band. Belugas moved up to 80 km from the ship track and remained away for up to 2 days. Finely et al. (1990) concluded that belugas were extraordinarily sensitive to shipping activity in spring, and that masking by industrial noise conceivably could result in reduced navigational and foraging capabilities, thereby leading to physiological stress and reduced fitness of populations. Results of Finely et al.'s (1990) study was corroborated by Cosens and Dueck (1993).

Temporary behavioral responses are usually not 'biologically significant' (affecting survival) (Erbe, 2002). Erbe (2002) notes that animals would have to be repeatedly disturbed during important behavior (e.g., nursing, mating, foraging) or be permanently frightened from critical habitat for the effects to be biologically significant. However, even short-term behavioral responses carry energetic costs. Such energetic costs could have long-term population consequences if, for example, a population were food limited or affected by additional cumulative stressors (Williams, Lusseau, and Hammond, 2006).

Gray Whale. Gray whale response to stationary noise sources indicates avoidance and behavioral modification that includes altering travel path or deflecting slightly around drill operations (Malme et al.,

1984). Gray whales are not present during winter and early spring when ice cover predominates. Summer feeding and fall migrating gray whales could be exposed to the noise introduced to the marine environment, and avoidance response would be anticipated.

Effects of drilling operations can cause slight deflection of some migrating whales from their original travel route; however, the deflection is transitory after passage of a drillship or platform after an avoidance deflection occurs. Synergistic adverse effects as a result of platform placement and construction, drilling, and other concurrent activities are avoided or minimized by application of mitigation measures that avoid or minimize the footprint of multiple activities relative one another and to the gray whale biological activities and movement. Localized prey concentrations, in part, may be locally avoided by some whales when in close proximity to active drilling operations; however, gray whales, like bowhead whales, may be more likely to tolerate noise when motivated to feed in such areas. Similar tolerance responses of gray whales under similar circumstances are uncertain. It is unknown whether tolerating higher level noise exposure in high-concentration feeding areas results in TTS (no tissue damage, but temporary reduction in hearing sensitivity) or PTS (resulting in tissue damage and permanent loss of hearing sensitivity) in gray whales. It is uncertain whether individual gray whales could experience TTS or PTS.

4.4.1.8.1.2. Potential Effects from Vessel and Aircraft Disturbances. The stationary presence of vessels and aircraft can also result in disturbances to marine mammals. Some of these disturbances may have been covered under the section on underwater noise from vessels and aircraft (Sections 4.4.1.8.1.1.1 and 4.4.1.8.1.1.2), but this section covers the physical presence of vessels and aircraft or associated above-water noise. Icebreaker activity, in particular, can enter ice-covered areas where pinnipeds are hauled out on the ice (for example: helicopters idling on ice and barges running to maintain position at islands). This section also addresses the potential for collisions or vessel strikes with marine mammals.

4.4.1.8.1.2.1. Vessel Disturbance. The physical presence of a vessel can elicit a response from marine mammals. Normally this occurs at a haulout (land or ice). The end of this section also addresses the potential for a vessel to strike and injure or kill marine mammals while underway.

Ringed, Spotted, Ribbon, and Bearded Seals. There are wide-ranging responses recorded for the reaction of seals to icebreaking activity. Seals may be disturbed by vessel traffic. Disturbance could motivate seals to leave haulout locations and enter the water. However, there are few published studies addressing pinniped responses to vessels and aircraft (Richardson et al., 1995a). Jansen et al. (2006) reported that harbor seals approached by ships at 100 m were 25 times more likely to enter the water than were seals approached at 500 m. However, they also reported that seal abundance in Disenchantment Bay, Alaska steadily increased during the summer in concert with increasing ship traffic (i.e., no short-term avoidance of areas used by ships), suggesting that changes in overall abundance were influenced by other factors. Harbor seals in their study area did aggregate more closely with increasing ship presence, similar to studies of other marine mammals that show denser aggregations during periods of disturbance.

Strandberg, Embacher, and Sagriff (1984) concluded that seals tend to remain on the ice or in their breathing holes just a few tens of meters away from a ship moving through the pack ice in Admiralty Inlet (Canada). After the ship had passed, seals tended to move into the ship's track, similar to their response to natural openings. There also are reports of ringed and bearded seals hauling out onto the ice when approached by an icebreaker (Fay and Kelly, 1982). There are other reports of ringed and bearded seals diving into the water when an icebreaker is 0.93 km away (Brueggeman et al., 1992) but remaining on the ice when the icebreaker was 1-2 km away (Kanik, Winsby, and Tanasichuk, 1980). Such an occurrence is unlikely considering the fact that ringed seal adults use an average of 3.4 holes per seal for breathing

(Hammill and Smith, 1989) and ringed seal pups use an average of 8.7 breathing holes, spaced up to 900 m apart (Lydersen and Hammill, 1993). When an icebreaker approaches one hole, the pup can escape to a safer location nearby. Seals also may be attracted to the wake of an icebreaker because of the ease at which breathing holes can be maintained.

The majority of ice seals are believed to follow the ice edge as it progresses seaward. Icebreaking activities in the Northwest Territories and Labrador did not adversely affect ringed seal abundance (Alliston, 1980, 1981). Since mortalities of ringed seals have been associated with icebreakers (Reeves 1998) we must assume moderate levels of effects to ringed seals should continue to occur from current levels of vessel traffic.

Pacific Walrus. Vessel traffic could disturb walrus at sea, along the ice edge, or within spring lead systems and may interrupt the movements or foraging of walrus by temporarily displacing some animals when the vessels pass through the area. This could occur regardless of the level of underwater noise associated with the vessel. Such traffic is not likely to have more than a short-term (a few hours to a few days) effect on walrus movements or distributions; but the displacement of walrus could have a localized effect on the availability of these animals to subsistence hunters for that season. Icebreaker activity physically would alter some ice habitats. This could temporarily destroy some potential resting habitat in pack-ice areas or provide access to additional areas by opening up new leads. Repeated disturbance from vessel traffic could have energetic costs and has the potential to separate calves from their mothers. The level of impact would depend on the amount of disturbance.

The reaction of walrus to vessel traffic appears to depend on vessel type, distance, speed, and previous exposure to disturbances. Weather and the length of time that the walrus already have been hauled out also affects the level of response. Walrus respond more quickly to visual and auditory sources of disturbance when the weather is calm and the ambient noise level is low. Walrus also respond more quickly when they have already been hauled out and at rest for some time, or when young calves are present in the herd. Brueggeman et al. (1991) reported that 81% of walrus encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walrus may sometimes be tolerant of ship activities and movements. Ice-management operations are expected to have the greatest potential for at sea disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near background levels. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (GarlichMiller, 2006, pers. commun.). Potential effects of prolonged or repeated disturbance include displacement from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water.

Beluga Whale. During exploration drilling, each floating drilling unit probably would have one vessel remaining nearby for emergency use. Depending on ice conditions, drill ships may have two or more icebreaking vessels standing by to perform ice-management tasks. It is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, belugas probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit, and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with exploration are not expected to disrupt migration, and small deflections in swimming paths and a reduction in use of possible feeding areas near exploration units should not result in significant adverse effects on the species. During their spring migration (April through June), belugas likely would encounter few, if any, vessels along their migration route, because ice at this time of year

typically would be too thick for seismic-survey ships, drillships, and supply vessels to operate in. For toothed whales, it is reasonable to assume that larger and noisier vessels, such as icebreaking ships, would have greater and more dramatic impacts on behavior than would smaller vessels.

Gray Whale. Section 4.4.1.6.1.1.1.2 provides a general background on the effects of noise and disturbance on other cetaceans. Effects to gray whales are considered to fall within the range of other baleen whales.

Collisions. Marine vessels potentially could strike pinnipeds or whales, causing injury or death, especially if a marine mammal cannot move clear of a fast-moving vessel. Available information indicates that current rates of vessel strikes of pinnipeds and whales are low. It is reasonable to assume that risk of strikes would increase as vessel traffic increases; however, available data do not indicate that strikes of pinnipeds or whales by vessels are or would become an important source of injury or mortality.

Additional injury or mortality could affect ice seals in snow dens. A seal could be struck if it becomes trapped in a den with no escape routes; however, this is limited to icebreaker activity and, due to noise associated with the approaching icebreaker, appears to have a low potential for occurring.

4.4.1.8.1.2.2. Aircraft Disturbance. Most offshore Beaufort Sea aircraft traffic in support of OCS oil industry involves turbine helicopter straight line flights for personnel transport and fixed-wing aircraft engaged in monitoring activities. An example of the potential volume of traffic is indicated during a typical “open water period” (June 16–October 31) in 2001, when there were approximately 989 roundtrip helicopter flights to Northstar Island. Most commercial aircraft traffic occurs along the coast as cargo and passenger service to villages. Some research vessels and USCG icebreakers have helicopters onboard which may occasionally conduct missions for research or rescue purposes offshore.

Ringed, Spotted, Ribbon, and Bearded Seals. Born et al. (1999) reported that the probability of hauled out ringed seals responding to aircraft overflights with escape responses was greatest at lateral distances of <200 m and overhead distances <150 m. Generally speaking, a significantly greater number of ringed seals responded to helicopter presence than to fixed-wing aircraft presence, and at greater distances. Ringed seals up to 2.3 km from approaching helicopters have been known to vacate the ice (Burns et al., 1999).

Ringed and bearded seals hauled out on ice often dive when approached by low flying aircraft or helicopters (Harbo, 1972, Burns and Frost, 1979, and Allison, 1981, as reported in Richardson et al. 1995a), but do not in all instances (e.g., Burns et al., 1982). Some ice seals might be disturbed from their haulouts and enter the water, although their responses could be highly variable and brief in nature. The effects of the existing level of air traffic on ice seals in the action area are expected to be localized and brief. Current and expected amounts of aircraft-related disturbances are expected to result in negligible levels of impacts to ice seals in the Beaufort Sea analysis area.

Pacific Walrus. Air traffic could disturb hauled-out walrus, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing walrus hauled out on the ice or at coastal haulouts. Aircraft disturbance of hauled-out walrus could result in injury or death, particularly to young walrus calves. Although air-traffic disturbance would be very brief, the effect on individual walrus calves could be severe, if the calves were injured or abandoned by their mothers. As walrus spend more time ashore due to receding ice, the potential for disturbances to cause stampedes also increases. Increases in physiological stress of adult or juveniles may reduce fitness and have implications for productivity and survivorship.

Walrus will flee haulout locations in response to disturbance from aircraft, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances, and walrus in the water are thought to be more tolerant to disturbance stimuli than those hauled out on land or ice. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea-ice habitats have reported little reaction to aircraft above 2,500 ft. However, walrus hauled out onshore respond more readily to stimuli, including small aircraft above 2,500 feet (762 m) and commercial jets.

Beluga Whale. Richardson et al. (1995a) described reactions of beluga whales to aircraft presence, but it remains unclear if these reactions were due to aircraft presence or aircraft noise transmitted to the marine environment. These reactions are described in Section 4.4.1.8.1.1.2, Aircraft Noise.

Gray Whale. Mother-calf pairs of gray whales have been reported to be sensitive to turboprop survey aircraft at 335+ m ASL. The calf usually moved under the adult or the adult moved over the calf. Migrating grey whales showed little response to straight-line overflights by a Twin Otter at 60 m ASL (Richardson et al. 1995b).

4.4.1.8.1.3. Potential Effects from Subsistence Hunting. The following section describes the subsistence harvest of marine mammals under the MMPA and how this relationship is affected by past, present, and reasonably foreseeable events as well as increased OCS leasing.

Ringed, Spotted, Ribbon, and Bearded Seals. Sections 3.4.2.2 and 4.4.1.12 provide greater detail on the importance of ice seals in the culture and diet of Native subsistence hunters. Sections 3.3.6.1.1 thru 3.3.6.1.4 contain information relating to estimated annual harvest of northern ice seals in the Alaskan Chukchi and Beaufort seas. As stocks increase or decline, harvest quotas are adjusted through an agreement between the Inuvialuit Game Council and the NSB (see Section 4.4.1.12). Lowry (2000) suggests a northward shift in the occurrence and distribution of ice seals due to climate change may have major effects on subsistence activities in the Beaufort Sea because of shifting distributions of key species, including ice seals. The current and anticipated impacts of subsistence harvesting on ice seals is expected to result in moderate levels of effects on ringed, bearded, and spotted seals in the proposed action area. Ribbon seals are extremely rare in the Beaufort Sea and subsistence use is not expected to affect these few individuals.

Pacific Walrus. Walrus are an important subsistence resource in coastal villages in Alaska. From 1998-2007, an average of 27 walrus were harvested along the Beaufort Sea coast by the villages of Barrow, Nuiqsuit, and Kaktovik. From 1998-2007, an average of 110 walrus were harvested along the Chukchi Sea coast by the villages of Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, Buckland, Deering, Shishmaref, and Wales (unpublished FWS data, 2008, Jonathon Snyder, pers. commun.). As walrus increase their use of coastal haulouts, they may become more vulnerable to subsistence hunting and sources of anthropogenic disturbances. Conversely, while walrus may be more available to hunters in some areas, they may become less available in others as changes in sea-ice range and extent create changes in patterns of movement and habitat use. Currently, the size of the Pacific walrus population is unknown and, therefore, a reliable estimate for a sustainable PBR cannot be determined. For more information on subsistence, see Section 4.4.1.12.

Beluga Whale. Beluga whales have been and are hunted by many communities throughout the Chukchi Sea across the Beaufort Sea and into Canada. In Alaska, the Alaska Beluga Whale Committee coordinates management of the hunt. The PBR is 324 animals for the Beaufort Sea stock (Angliss and Outlaw, 2008). Annual Alaskan Native subsistence take of Beaufort Sea stock averaged 53 animals

during 1999-2003. Mean estimated take, including struck and lost estimates, in Canada and only those landed in U.S. waters from the Beaufort Sea is 152-186 belugas per year (Angliss and Outlaw, 2008; CDFO, 2000). This removal is likely an underestimate, as it does not include struck and lost rates for the U.S. There are no reports of harvested killer whales, harbor porpoises, or narwhals from stocks in U.S. waters in the planning areas.

There are adverse effects of hunting belugas in addition to the death of animals that are successfully harvested. Serious injury is incurred by animals that are struck but not recovered. Data on strike and harvested levels indicate that whales are not always immediately killed when struck. Some whales are struck but cannot be harvested. Huntington and Mymrin (1996) reported a beluga harvested about 1995 that had a musket ball in it, a type of bullet that had not been used in more than 50 years. In Canada, reported struck and lost removal added an additional 68% (75 whales) to the landed catch (111 whales). Available evidence indicates that subsistence hunting also causes disturbance to other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths (Huntington et al., 1999; Huntington and Mymrin, 1996). Modern subsistence hunting represents a source of noise and disturbance to the whales during their northward spring migration in the Bering Sea; in the Beaufort Sea spring lead system near Barrow; during their fall westward migration in subsistence-hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow. Whales in the vicinity of the struck whale could be disturbed by the noise of the hunt, the boat motors, and any sounds made by the injured whale. While it is unknown if belugas issue alarm or distress calls after being struck, it is known that belugas possess a complex acoustical communication system and that among the various dolphin sounds are those relating to excitement, alarm, fright, and threat (Herman and Tavolga, as cited in Erbe, 1997).

Available data are insufficient to determine whether there are longer term (i.e., longer than when hunting is occurring) changes in habitat use due to hunting. However, traditional ecological knowledge suggests that belugas react to approaching outboard-motor noise during harvest by short-term dives (up to about 20 minutes), are sensitive to some ultra-high-frequency transmissions, and react to the noise of gunshot (Huntington and Mymrin, 1996).

Noise and disturbance from subsistence hunting serves as a seasonally and often geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil- and gas-related activities, add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. While belugas may habituate to some constant noise sources, they appear to avoid variable anthropogenic noise (e.g., boats, helicopters, onshore noises). However, belugas may be capable of habituation to considerable noise that is unassociated with hunting (Huntington et al., 1999).

We are not aware of information indicating long-term habitat avoidance has occurred with levels of activity that are occurring or that have occurred in the recent past. Subsistence take of beluga whales appears to be sustainable, and the population appears robust.

In summary, the subsistence take of belugas is small compared to the capacity of the population to absorb it. However, we are aware of no other known potential human-related effects that approach, or could reasonable be predicted to approach, the level of this known removal. This activity also results in noise and disturbance that may have temporary effects on habitat use but are mostly nonlethal. We are not aware of information suggesting there have been any long-term modifications of habitat use due to this form of disturbance. However, we also emphasize that the hunt is regulated, has limits on take, and does not exceed the PBR rate.

Current mitigation of oil and gas activities is aimed primarily at avoiding harm to belugas from the activity, and to ensuring that the activity does not conflict with subsistence hunting of belugas. Because most sounds important to belugas are predominantly at much higher frequencies than are seismic airgun noise, masking effects are not expected to be present for beluga communication and echolocation.

Belugas are fundamentally important for cultural, nutritional, and economic reasons. Native communities and hunters from many communities conduct annual hunts for belugas.

Native communities are concerned that offshore oil and gas development activities such as seismic exploration may negatively impact their ability to harvest marine mammals. Because of this, and because hunts usually take place during discrete, predictable time (e.g., late June to late July) and because even small disturbances to belugas can impact the hunt and alter beluga behavior, area closures should be considered to protect the beluga hunts.

Gray Whale. Gray whales are taken by both Alaskan and Russian subsistence hunters; however, most of the harvest is done by the Russians. The only reported takes in Alaska in occurred in 1995, when Alaskan Natives harvested two animals (IWC, 1997, as cited in Angliss and Outlaw, 2008). In 1997, the IWC implemented an annual cap of 140 gray whales to be taken by Russia and the U.S. The U. S. and Russia have agreed that the quota will be shared, with an average annual harvest of 120 whales by the Chukotka people and 4 whales by the Makah Indian Tribe in Washington State. The annual subsistence take averaged 122 whales during the 5-year period from 1999-2003.

4.4.1.8.1.4. Potential Effects from Habitat Loss. This section refers to direct habitat losses as compared to changes in habitats arising from climate change. Sources of habitat loss include community and industrial development. This section does not address the loss of sea-ice due to climate change (addressed in 4.4.1.8.1.7).

4.4.1.8.1.4.1. Community Development. Some coastal and nearshore habitat loss may occur from the expansion of human activities in nearshore and coastal areas. For example, in the past, walrus have not used coastal haulouts along the Beaufort Sea coastline but, in 2007, a small coastal haulout formed near Barrow. As sea-ice retreat continues, walrus may come ashore and form haulouts in areas not previously identified as walrus habitat. These coastal haulouts may increase in importance for walrus; however, loss of access to coastal areas in the Beaufort Sea is likely to have negligible impacts to walrus as long as the bulk of the population remains in the Chukchi and Bering seas. Increases in numbers of subsistence users may reasonably lead to larger annual takes among ice seals.

4.4.1.8.1.4.2. Industrial Development. The primary causes of habitat loss could occur from drilling wastes discharged during exploration or production drilling and construction of production islands and associated facilities in the marine environment.

Ringed, Spotted, Ribbon, and Bearded Seals. Blackwell (2003) determined that ringed seal densities were significantly higher around offshore industrial facilities. Another study (Lowry and Frost 1988) also found that in the years 1985 and 1986 ringed seal densities were higher in industrialized areas than in the controls. Frost and Lowry (1988) found that the densities of ringed seals were highest in industrial blocks that in control blocks in the Central Beaufort Sea with the greatest increase in industrialized density occurring when human activity dropped off in 1987.

4.4.1.8.1.4.2.1. Drilling Wastes. Exploration drilling could result in the disposal of drilling muds or cuttings onto the seafloor under terms of an EPA NPDES permit. The accumulation of these muds on the seafloor could result in a direct loss of marine mammal foraging habitat.

Muds and cuttings from development drilling from production platforms are expected to be treated and disposed of in disposal wells. Muds and cuttings from satellite development wells are expected to be barged either to the host platform for downhole disposal or to shore for disposal. Produced waters are expected to be re-injected.

4.4.1.8.1.4.2.2. Industrial Facilities. The construction of artificial offshore islands to support production drilling platforms and pipelines could reduce the amount of habitat available to marine mammals in the Beaufort Sea. Dredge-fill material associated with existing exploration-drilling units that have been installed or constructed in the Beaufort Sea as a result of past Federal and State oil and gas leases have altered at least a few square kilometers of benthic habitat in the Beaufort Sea. Abandonment of these facilities could also have adverse effects.

Bottom-founded drilling units and/or gravel islands may cover areas of benthic habitat that support benthic invertebrates used for food by marine mammals.

Gravel island-construction activities, including placement of fill material, or installation of sheetpile or gravel bags for slope protection could cause loss of habitat, depending on the location of the gravel island. This construction would cause temporary sediment suspension or turbidity in the marine environment. Alterations from island construction, trench dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 km for <1 year or season. These activities are not expected to affect food availability over the long term because, for example, prey species for belugas, such as arctic cod, have a very broad distribution and belugas are able to forage over large areas of the Beaufort Sea and are not reliant exclusively on the abundance of local prey. In other instances, gravel islands or other fill may provide habitat for some prey species.

4.4.1.8.1.5. Potential Effects from Environmental Contaminants. Disposal of drilling muds and cuttings would be as specified under conditions prescribed by an EPA NPDES permit. Exploration drilling muds and cuttings may cause localized contamination of the seafloor. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution/deposition of these materials.

Ringed, Spotted, Ribbon, and Bearded Seals. Previous studies (Becker 1995) have found quantities of contaminants such as PCBs, DDT, chlordane, toxaphene, and numerous heavy metals in the carcasses of ringed seals in the Beaufort and Chukchi seas. Woshner (2000) analyzed the accumulations of selenium, mercury, silver, cadmium, and other potentially toxic metals in ringed seals from the Beaufort Sea and other areas. Becker (1995) concluded that the levels of heavy metals in ringed seals most likely were a product of accumulation over the age of the seal and the geology of an area, which is supported by other studies (Dietz et al., 1998). The levels of contaminants detected in Beaufort and Chukchi sea seals were similar to or less than levels found in other populations of a respective species (Becker 1995). At the detected levels, these contaminants do not appear to pose a serious threat to the individual seals or to their consumers. Environmental contaminants from current and future developments in the proposed action area are expected to result negligible levels of impacts to ice dwelling Phocid seals in the Proposed Action area.

Pacific Walrus. Very little information has been published on the effects of contaminants on the Pacific walrus, and no analysis of cumulative effects has been published. Pacific walruses are a long-lived species that feed primarily on benthic invertebrates, some of which are known to concentrate contaminants (Doroff and Bodkin, 1994). Walruses also are an important food source for a number of coastal Alaskan villages (Egelund, Feyk and Middaugh, 1998). The State of Alaska Epidemiology

Department has evaluated the most recent heavy metal and persistent organic chemical contaminant analyses with regard to Pacific walrus and continues to recommend no restrictions on human consumption of walrus meat (Ponce et al., 1997; Egeland, Feyk and Middaugh, 1998).

A recent contaminants study of Pacific walrus used samples collected in the Bering Sea in 1991. Seagers and Garlich-Miller (2001) analyzed levels of organochlorine compounds and aliphatic hydrocarbons from 27 blubber samples. The authors compared their results with samples collected in 1981 through 1984 (Taylor et al., 1989) and with samples collected in 1972 (Galster and Burns, 1972). In the most recent study, DDT and its metabolites were not detected. Chlorinated hydrocarbons also were absent or below detection levels. Very low traces of Lindane and related isomers (range of 0.02-0.17) were detected. Very low but detectable amounts of Dieldrin, heptachlor epoxide, and oxychlordan were found in most samples. Very low levels of PCBs also were detected in 19 samples. The authors concluded that concentrations of organochlorine pesticides were far below levels where contaminant-induced immunosuppressive effects have been shown to occur in pinnipeds elsewhere in the world. In addition, traces of aliphatic hydrocarbons were detected in all samples in concentrations below levels associated with recent exposure to petroleum pollutants.

Warburton and Seagers (1993) compared metal concentrations from 56 liver and kidney samples collected from 1986-1989 with 57 samples collected from 1981-1984 (Taylor et al, 1989). While still low, trace levels of selenium, arsenic, and lead increased significantly between the two time periods. Selenium was the highest at 17.6 parts per million (ppm). Levels of cadmium and mercury did not increase; however, cadmium levels remained high (mean of 166.5 ppm). Unfortunately, there is no information to determine whether or not there are health effects for walrus at this cadmium level. Although human industrial activities can be significant point sources for cadmium, cadmium also occurs naturally throughout the environment. High cadmium levels may be naturally occurring in the environment of Pacific walrus and not due to anthropogenic sources.

Beluga Whale. Section 4.4.1.6.1.1.1.10 describes the general background on potential effects from drilling discharges, and that information is incorporated by reference here as it directly applies to impacts of discharges on beluga whales. The major threat to belugas elsewhere is pollution of their environment. Contaminants that enter the sea tend to become concentrated as they move up the food chain, and they could pose a health risk to beluga and other top marine predators. Organochlorines such as PCBs, pesticides, and other persistent organic pollutants (POPs) are of concern. In Russia, high levels of PCBs are found in the Kara and Laptev seas, possibly due to inputs from several large rivers that flow into these seas. Also, concentrations of PCBs and other POPs are high in some parts of the Barents Sea and around Svalbard (Boltunov and Belikov, 2002). Dead belugas found along the shores of the St. Lawrence River have contained high levels of organochlorines, lead, and mercury, but it is not known what effect their presence has at the population level (Kingsley, 2002). About 23% of dead adults found on the shores of the St. Lawrence have malignant cancers but again, it is not known if this has consequences for the population (North Atlantic Marine Mammal Commission, 2004). For the first time, researchers recently demonstrated that mercury levels in beluga muscle tissue reflect biomagnification processes rather than bioaccumulation over time. Researchers found that beluga length defined habitat specificity, and the consequent difference in habitat use resulted in different diets and dietary mercury sources (Loseto, Stern, and Ferguson, 2008).

Gray Whale. There could be alterations in gray whale habitat as a result of exploration well discharges, including localized smothering of seafloor habitats. We refer readers to the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a) for a detailed discussion of drilling muds and other discharges associated with exploration drilling, with probable scenarios regarding the disposal of these substances and for discussion of the potential effects on water quality from their discharge. Any potential adverse effects on

baleen whales from discharges are directly related to whether or not any potentially harmful substances are released, if they are released to the marine environment, what their fate in that environment likely is (e.g., different hypothetical fates could include rapid dilution or biomagnification through the food chain) and, thus, whether they are bioavailable to the species of interest.

4.4.1.8.1.6. Potential Effects from Petroleum Spills. Numerous studies have demonstrated that spilled oil can have dramatic and lethal effects on marine mammals (see St. Aubin, 1990a). The persistence of toxic subsurface oil and chronic exposures, even at sublethal levels, can have long-term effects on wildlife (Peterson et al., 2003). For example, as a result of the *Exxon Valdez* oil spill (EVOS), oil persisted in surprising amounts and in toxic forms in coastal areas of Southcentral Alaska and was sufficiently bioavailable to induce chronic biological exposures in animals for more than a decade, resulting in long-term impacts at the population level, particularly for species closely associated with shallow sediments (Peterson et al., 2003). Oil effects can be substantial over the long term through interactions between natural environmental stressors and compromised health of exposed animals, and through chronic, toxic exposure as a result of bioaccumulation (Peterson et al., 2003). Section 4.4.1.6.1.1.1.11, Potential Effects of Large and Small Petroleum Spills, describes the potential effects from petroleum spills to baleen whales.

Ringed, Spotted, Ribbon, and Bearded Seals. Contact with crude oil in the Proposed Action area most likely would harm ice seals (NRC 2003b). The more volatile compounds in an oil slick, particularly aromatic volatiles, usually are the most toxic components in an oil slick. In situ, cold-water measurements (Payne et al., 1984) have demonstrated that individual compounds in a slick decrease significantly in concentration in hours to tens of days. Investigations into the effects of crude oil ingestion and exposure on ringed seals (Smith and Geraci, 1976) indicate the probability of ringed seals accidentally ingesting large amounts of oil by way of contaminated food items is unlikely. Moreover, only small, transient effects were found to have occurred during necropsies of ringed seals deliberately fed potent fractions of carbon tetrachloride.

Immersion studies by Smith and Geraci (1976) found that ringed seals often develop mild liver damage from immersion in crude oil. However, in those same studies, kidney lesions and eye damage did occur. Furthermore the eye damage observed often was severe, indicating permanent eye damage might occur with longer lengths of exposure to crude oil. Overall, the severity of the damage is most likely associated with the length of exposure to a crude oil spill. Older seals and seals in weaker physical condition were most likely to show greater sensitivity to immersion in crude oil. Under existing and expected development scenarios moderate levels of impacts are expected for ice seals from petroleum spills. This assumption is based on the development and implementation of oil spill response plans and adequate clean-up activities and the propensity of ice seal to maintain a dispersed distribution in most cases. Spotted seals are the exception to this rule as a species, however they maintain very low numbers in the Beaufort Sea, usually in more protected areas such as Harrison Bay, etc. Up to now ribbon seals sightings have been extremely rare in the Beaufort Sea, occurring primarily around Point Barrow. Consequently spotted seals and ribbon seals should be negligibly affected by any oil spills occurring in the proposal area in part because of their scarcity.

Pacific Walrus. Due to the tendency of walruses to aggregate in large groups, their longevity, and their low rates of reproduction, walruses are particularly vulnerable to population-level perturbations and would require more time to recover from population-level impacts than would species with different life-history strategies. Furthermore, potential impacts to female walruses and dependent calves are a major concern and merit special consideration.

Walrus are most vulnerable to the effects of an oil spill at coastal haulouts and when congregated along the ice edge or in spring lead systems. Displacement from these crucial areas likely would result in population-level impacts on recruitment and survival. Walrus are long-lived animals with low rates of natural mortality and low rates of reproduction. This life-history strategy would severely limit the ability of the Pacific walrus population to recover from adverse impacts that result in large numbers of mortalities associated with a large oil spill. Therefore, an oil spill that occurred at or near a large aggregation of walrus could have a major impact on the Pacific walrus population.

Because walrus can be considered a top predator of the Arctic ecosystem, they are biological sinks for lipophilic pollutants that biomagnify up the food chain (Norstrom et al., 1988). Consequently, walrus would be very susceptible to the effects of bioaccumulation of contaminants associated with spilled oil, which would affect their reproduction, survival, and immune systems (USDOJ, MMS, 2004:Section IV.E.2.e(1)(c)). Sublethal, chronic effects of any oil spill can be expected to suppress the recovery of walrus populations due to reduced fitness of surviving animals. Sublethal doses of oil contaminants can cause delayed population impacts such as compromised health, growth, reproduction, and reduced survival in generations born after the spill (Peterson et al., 2003). Additionally, reductions in walrus prey resulting from an oil spill could result in reduced walrus recruitment and survival.

Determining oil-spill effects on walrus prey species is difficult. Clam-patch size and density are highly variable, and such information for high-latitude mollusks is sparse and highly variable (Ray et al., 2006). However, walrus feeding may deplete areas of prey quickly and alter community composition (Ray et al., 2006). The large mollusks that walrus feed on are mostly slow-growing species and, thus, vulnerable to overexploitation or other disruptions (e.g., oil spills) to their populations (Ray et al., 2006). Recovery from any disruption would be slow in the cold, seasonally ice-covered Chukchi Sea (Oliver et al., 1983). For example, populations of amphipods (another benthic invertebrate) off the coast of France were reduced by 99.3% following the *Amoco Cadiz* oil spill in 1978 (~70 million gal). Ten years after the spill, amphipod populations had recovered to only 39% of their original maximum densities (Dauvin, 1989, as cited in Highsmith and Coyle, 1992). Because walrus are long-lived animals at the top of the food chain and, thus, subject to the upward biomagnification of contaminants, the effects from contaminants on the Pacific walrus population from a large oil spill are likely to persist for decades.

Killer Whale. Cetaceans that inhabit areas that are in the path of a major oil spill can be impacted in several different ways. First, individuals potentially could be directly affected by contact with the oil or its toxic constituents through inhalation of aromatic fractions of unweathered oil (probably the most serious threat to cetaceans), ingestion (of oil or contaminated prey), and contact with skin. Second, they could be indirectly impacted if the quality or quantity of their prey were reduced. Third, individuals could be directly or indirectly affected due to maternal effects (e.g., changes in food assimilation during pregnancy, or reduced maternal health) or in-utero exposure to toxic components of oil. Fourth, they could be affected by disturbance of spill-response and cleanup activities.

Toothed whales do not seem to consistently avoid oil, although they can detect it (Geraci, 1990). Matkin et al. (1994) reported that killer whales had the potential to contact or consume oil, because they did not avoid oil or avoid surfacing in slicks. In the 2 years following the EVOS, significant numbers (13) of individual whales, primarily reproductive females and juveniles, disappeared from the AB pod. This mortality was significantly higher than in any other period except when killer whales were being shot by fishers during sablefish fishery interactions (Matkin et al., 1994). Harvey and Dahlheim (1994) observed 18 killer whales, including 3 calves, and saw the pod surface in a patch of oil. Dahlheim and Matkin (1993) also reported seeing AB pod members swim through heavy slicks of oil. Dahlheim and Matkin (1994) concluded that there is a spatial and temporal correlation between the loss of the whales and the EVOS, but there is no clear cause-and-effect relationship. Based on evidence of observation of individuals from the AB pod of killer whales in heavy oil, and large disappearances of whales from the

AB pod in the 2 years following that exposure (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994), one could conclude that whales are vulnerable if they are present within a large spill, probably due to inhalation. However, this link is circumstantial, and there is not agreement in the scientific community as to whether or not there likely was an oil-spill impact on killer whales after the EVOS.

Based on literature on other mammals indicating severe adverse effects from inhaling the toxic aromatic components of fresh oil, mortality of cetaceans could occur if they surfaced in large quantities of fresh oil. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, can cause sudden death (Geraci, 1988). This is most likely if calves were exposed to fumes from a large spill. Calves take more breaths than do their mothers and spend more time at the surface. Thus, they potentially would be most likely to succumb to inhalation of toxic aromatic compounds.

Geraci and St. Aubin (1982) calculated the concentrations of the more volatile fractions of crude oil in air associated with a theoretical spill of a typical light crude oil. Their results showed that vapor concentrations could reach critical levels for the first few hours after a spill. Animals that are away from the immediate area or that are exposed to weathered oils would not be expected to suffer serious consequences from inhalation, regardless of their condition. The most serious situation would occur if oil spilled into a lead from which whales could not escape. In this case, Bratton et al. (1993) theorized that whales could inhale oil vapor that would irritate their mucous membranes or respiratory tract. They also could absorb volatile hydrocarbons into the bloodstream. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them. The number of whales affected would depend on how large the spill was, its behavior after being spilled, and how many whales were present in areas contacted in the first days following the spill.

Based on all available information, if individual, small groups or, less likely, large groups of whales were exposed to large amounts of fresh oil, especially through inhalation of highly toxic aromatic fractions, they might be seriously injured or die from such exposure. Although there is very little definitive evidence linking cetacean death or serious injury to oil exposure, disappearances (and probable deaths) of killer whales coincided with the EVOS and with observations of members of the species in oil. However, in these two cases, even if one assumed that the disappearances of the killer whales were the result of the coinciding oil spill, it is unlikely that there would be a population-level adverse effect in the event of a large oil spill.

Beluga Whale. There exists the possibility of a situation in which belugas are at particular risk in the event of a large oil spill. The situation would be if a large or very large spill occurred while the whales were migrating through the Beaufort Sea traveling through the spring leads and polynyas, particularly if it is a period when large numbers of females are accompanied by calves. Calves would be more vulnerable than adults, because they would be more restricted to open water within the lead system, have less physical ability to avoid the open water within the lead system by traveling under the ice, or breaking ice to breathe. The effects of an oil spill on cetacean newborns or other calves are unknown. The potential effects of contact or detection of spilled oil by near term or postpartum females are unknown. The spring migration across the Alaska Beaufort Sea is dependent on the open leads occurring offshore. The potential exists for a substantial mortality and sublethal effects to a cohort of calves if a large spill of fresh oil (evaporating high concentrations of volatile toxic components into the atmosphere immediately above the water) occurred during spring migration, or spilled oil concentrated in the polynya system when whales, including calves, were passing through in large numbers and experiencing prolonged contact and exposure to inhalation of volatile components of spilled oil.

The effects of a large oil spill and subsequent exposure of whales to fresh crude oil are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact, the amount of oil spilled, and the age/degree of weathering of the spilled oil at the time of contact. The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating whales, a large portion of the population could be exposed to spilled oil. If a very large slick of fresh oil contacted a large aggregation or aggregations of feeding whales, especially with a high percentage of calves, the effect might be expected to be greater than under more typical circumstances.

There is great uncertainty about the effects of fresh crude oil on cetacean calves. Prolonged exposure to freshly spilled oil could kill some adult whales but, based on available information, the number likely would be small if the spill contacted them in open water. However, Engelhardt (1987) theorized that some whales would be particularly vulnerable to effects from oil spills during their spring migration into arctic waters because of their use of ice edges and leads, where spilled oil tends to accumulate. Several other researchers (Geraci and St. Aubin, 1982; St. Aubin, Stinson, and Geraci, 1984) concluded that exposure to spilled oil is unlikely to have serious direct effects on whales. There is some uncertainty and disagreement within the scientific community on the results of studies on the impacts of the EVOS on large cetaceans (for example, Loughlin, 1994; Dahlheim and Matkin, 1994; Dahlheim and Loughlin, 1990). Ingestion, surface contact with, and especially inhalation of fresh crude oil has been shown to cause serious damage and even death in many species of mammals. This does not mean that such effects would occur. Such an assumption, if it provides an overestimate of potential effects, is more protective of the population than erring on the side of assuming that such impacts could not occur because they previously have not been documented.

Larger groups could be adversely affected if a large spill occurred when large aggregations of toothed whales were feeding or molting.

There are no data available on which to evaluate the potential effect of a large or very large spill on toothed whale calves, on females who are very near term or who have just given birth, or on females accompanied by calves of any age. However, it is likely that newborn and other young calves would be more vulnerable to the acute and chronic effects of oil than would adult toothed whales. Calves swim slower, take more breaths, are on the surface more often, and have higher metabolisms than do adults. They could be exposed to oil on their mother's skin during nursing. They could receive pollutants through their mothers' milk, as well as through direct ingestion.

It is likely that some toothed whales would experience temporary or perhaps permanent nonlethal effects, including one or more of the following symptoms:

- inhaling hydrocarbon vapors;
- ingesting oil and oil-contaminated prey;
- oiling their skin, causing irritation;
- losing some proportion of their food source; and
- temporary displacement from some feeding areas.

Some toothed whales could die as a result of contact with spilled oil, particularly if there is prolonged exposure to freshly spilled oil, such as in a lead.

The effects of oil contacting skin largely are speculative. In a study on nonbaleen whales and other cetaceans, Harvey and Dahlheim (1994) observed 80 Dall's porpoises, 18 killer whales, and 2 harbor

porpoises in oil on the water's surface from the EVOS. The 18 killer whales and 2 harbor porpoises were in oil but had none on their skin. None of the cetaceans appeared to alter their behaviors when in areas where oil was present. The authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present.

Histological data and studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect. Gasoline-soaked sponges also were applied to the skin up to 75 minutes produced transient damage to epidermal cells in whales. Subtle changes were evident only at the cell level. In each case, the skin damage healed within a week. The authors concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. Geraci and St. Aubin (1990) also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin. They found that following a cut, newly exposed epidermal cells degenerate to form a zone of dead tissue that shields the underlying cells from seawater during healing. They massaged the superficial wounds with crude oil or tar for 30 minutes, but the substances did not affect healing. Lead-free gasoline applied in the same manner caused strong inflammation, but it subsided within 24 hours and was indistinguishable from control cuts. The authors concluded that the dead tissue had protected underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in real life, contact with oil would be less harmful to cetaceans than they and others had proposed.

The potential for a-population-level effect may exist if large numbers of females and calves, especially newborn or very young calves, were contacted by large amounts of freshly spilled oil. However, if mortality of cetaceans occurred after exposure to a large oil spill, it would not be consistent with most published findings of impacts of oil spills on cetaceans. Information about environmental impacts on whales is rudimentary and full of speculation and uncertainty. Unless baseline data are exceptionally good, determination of an effect is only possible if the effect is dramatic. Thus, the potential for long-term sublethal (e.g., reduced body condition, poorer health, or longer dependency periods), or lethal effects from large oil spill on cetaceans is unknown. However, observations of cetaceans behaving in a lethargic fashion or having labored breathing have been documented in more than one species.

A large oil spill could result in large-scale effects to beluga prey species, including anadromous and coastal spawning species such as salmon. If wide-spread harm to anadromous and coastal spawning species occurred, the effects on belugas would be detrimental, but the magnitude is unknown. Any perturbation, such as an oil spill, which caused extensive mortality within a high-latitude amphipod population with low fecundity and long generation times, would result in a marked decrease in secondary production (Highsmith and Coyle, 1992). For example, populations of amphipods off the coast of France were reduced by 99.3% following the *Amoco Cadiz* oil spill in 1978 (~70 million gal). Ten years after the spill, amphipod populations had recovered to only 39% of their original maximum densities (Dauvin, 1989, as cited in Highsmith and Coyle 1992). Beaufort Sea amphipod populations, with their longer generation times and lower growth rates, probably would take considerably longer to recover from any major population disruption (Highsmith and Coyle 1992).

The potential for long-term sublethal (e.g., reduced body condition, poorer health, reduced immune function, reduced reproduction or longer dependency periods) effects on large cetaceans from a large oil spill essentially is unknown. There are no data on toothed whales adequate to evaluate the probability of sublethal effects.

Available information indicates it is unlikely that whales would be likely to suffer significant population-level adverse affects from a large spill originating in the Beaufort Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local

distribution and abundance. Any large oil spill in nearshore environment could cause injury or death to belugas or potentially cause them to move off of their normal course, and make them unavailable for subsistence harvest. The number of belugas or other toothed whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. Belugas may be vulnerable particularly to oil-spill effects due to their use of ice edges and leads where spilled oil may accumulate (Engelhardt, 1987:104). Primarily because belugas associate with and use spring leads and polynyas as a migratory path between wintering and summering grounds, we are uncertain of the potential severity of impact should a large or very large oil spill occur within such a system, especially if spring migration were under way and hundreds of females and calves were in or near those leads.

Beaufort Sea belugas migrate through waters where oil and gas exploration and development activities have existed for almost 20 years and where such activities are proposed for the future. These activities can affect belugas directly (e.g., underwater noise, aircraft, oil spill) or indirectly (e.g., habitat effects, prey affects). However, the likelihood and biological implications of these effects is largely unknown.

There is little information regarding temporary displacement of cetaceans from habitat affected by an oil spill or cleanup operations. After the EVOS, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented no effects on the humpback whale. Others (von Ziegesar, Miller, and Dahlheim, 1994) found no indication of a change in abundance, calving rates, seasonal residency time of female-calf pairs, or mortality in humpback whales as a result of that spill, although the authors did see temporary displacement from some areas of Prince William Sound.

Gray Whale. The effects of spilled petroleum are similar for baleen whales, including gray whales. Gray and minke whales are not expected to be present during periods of ice cover or in the spring open lead system and are expected during open-water periods only and not vulnerable to oil exposure in the open-lead system. Exposure to spilled petroleum during the open-water period where concentrations of prey and feeding gray or minke whales are present could occur. Migrating gray whales show only partial avoidance to natural oil seeps off the California coast. After the EVOS, gray whales were seen swimming through surface oil along the Alaskan coast. Laboratory tests suggest that gray whale baleen, and possibly skin, may be resistant to damage by oil. However, spilled oil, and the chemical dispersants used to break up surface oil and cause it to sink, could negatively affect gray whales by contaminating benthic prey, particularly in a primary feeding areas (Wursig, 1990; Moore and Clarke, 2002). Any perturbation, such as an oil spill, that caused extensive mortality within a high-latitude amphipod population with low fecundity and a long generation time would result in a marked decrease in secondary production (Highsmith and Coyle, 1992). For example, populations of amphipods off the coast of France were reduced by 99.3% following the *Amoco Cadiz* oil spill in 1978 (~70 million gal). Ten years after the spill, amphipod populations had recovered to only 39% of their original maximum densities (Dauvin, 1989, as cited in Highsmith and Coyle, 1992). Bering/Chukchi Sea amphipod populations, with their longer generation times and lower growth rates, probably would take considerably longer to recover from any major population disruption (Highsmith and Coyle, 1992).

4.4.1.8.1.6.1. Oil-Spill-Cleanup Effects. Cleanup operations following a large oil spill would be expected to involve multiple marine vessels operating in the spill area for extended periods of time, perhaps over multiple years. Information is provided in the discussion of impacts associated with vessel traffic (Section 4.4.1.8.1.1.1). After a large spill, there typically are helicopter and fixed-wing aircraft overflights to track the spill and to determine distributions of wildlife that may be at risk from the spill. Section 4.4.1.8.1.1.2 discusses the effects of aircraft to marine mammals. In the event of a large spill, both FWS and NMFS personnel would be on hand to conduct marine mammal surveys and to determine the best course of action to limit the potential impacts to marine mammals as much as possible. This may

include prioritizing clean up to particularly sensitive areas, hazing animals away from spilled oil and clean up activities, and capturing oiled animals for transfer to rehabilitation facilities.

Ringed, Spotted, Ribbon, Bearded Seals and Pacific Walrus. The effects from cleanup activities on pinniped species would be largely the effects of disturbance from vessels (previously addressed in Section 4.4.1.8.1.1), the effects of disturbance from aircraft (previously addressed in Section 4.4.1.8.1.2), and the effects of the spilled oil itself (previously addressed in Section 4.4.1.8.1.6).

Beluga Whales. The effects of clean up activities on beluga whales would be largely the effects of disturbance from vessels (previously addressed in Section 4.4.1.8.1.1). After a large spill, there typically are helicopter and fixed-wing aircraft overflights to track the spill and to determine distributions of wildlife that may be at risk from the spill. Section 4.4.1.8.1.2 discusses the effects of aircraft to beluga whales. Avoidance of spill cleanup operational vessels and low-flying aircraft by beluga would serve to buffer contact with spilled oil. It is anticipated that there could be displacement of beluga whales from a feeding areas or migration routes during a spill cleanup effort, and this displacement could last for the duration of the cleanup effort.

Gray Whale. Gray whale response to oil-spill cleanup operations may vary from escape behavior to changes in calling frequency and habituation to vessel and aircraft noise and activity. Avoidance of cleanup operational vessels and low-flying aircraft by gray whales would serve to buffer contact with spilled oil. There could be displacement of gray whales from a feeding areas or movement routes during a spill cleanup effort, and this displacement could last for the duration of the cleanup effort.

4.4.1.8.1.7. Cumulative Effects from Global Forces. Climate change has the potential for profound ecosystemwide effects in the Arctic physical environment (Ragen, Huntington, and Hovelsrud, 2008). Demonstrable changes in the Arctic have been evidenced over the last 50 years (Moore and Huntington, 2008). The Arctic is experiencing a trend of an annual decrease of summer sea-ice extent, greater extent and longer periods of open water, earlier sea-ice melt in spring and later formation in early winter, thinner annual sea ice, decreasing multiyear ice, and greater ice retreat from coastlines. Climate change impacts and trends are described more completely in Section 3.2.2.5.

Temperature Increases. Ongoing climate change is occurring at an unprecedented rate. Arctic ecosystems are believed to be relatively fragile with respect to large changes in climate. Of particular importance to arctic marine mammals is the presence of a sea ice covering for the Arctic Ocean. Temperature projections from calendar year (CY) 1990 through CY 2090 predict a 7 °C increase in air temperatures over the oceans, according to the Arctic Climate Impact Assessment (ACIA, 2004). The increasing temperatures also are believed to be a major underlying cause for the decrease in sea-ice extent from an estimated annual coverage of 13,000,000 km² in CY 1900 to around 11,000,000 km² in CY 2000. Refer to Section 3.2.4 for a more indepth explanation of ice-climate dynamics.

Increasing Terrestrial Runoff and Ice-Derived Freshwater. If the quantity of terrestrial runoff, melting sea ice, and melting glacial ice increases, the ensuing influx of freshwater into the polar seas could act to cool the upper layers of the ocean. This may result in an increase in the freezing point for sea ice, the possibility of a more rapid formation of fast and offshore sea ice, slowing of the thermohaline circulation, and an inhibiting effect on vertical mixing in the water column (ACIA, 2005).

Changes in Ice Cover. Sea-ice extent has decreased over the last 30 years by approximately 8%, and this trend is accelerating; meanwhile, the ice has thinned Arcticwide by 10-15%, and up to 40% in some areas according to AICA (2005). This presents a challenge for ice seals using the shallow coastal areas of

fast ice. Two such areas lie along the eastern Chukchi Sea and the Beaufort Sea coasts and in the analysis areas. A major recession in sea-ice persistence and presence may have profound direct and indirect impacts on pinniped species in the Beaufort and Chukchi seas (ACIA, 2005; Bluhm and Gradinger, 2008; Moore and Huntington, 2008; Mueter and Litzow, 2008; Davis et al., 2008; Moulton et al., 2002). The effects of the ongoing sea-ice loss will vary between species relative to the level of a species' relationship with sea ice, the dietary and behavioral plasticity, and physiology. Moreover if the arctic coastline in North America remains ice free for 100+ days as predicted, the analysis area could experience an increase in vessel traffic (AICA, 2005). Based on a five-model average, changes in sea-ice cover (ACIA, 2005) could exceed a 50% decline in arctic sea ice by CY 2100 if the current warming trends continue. The subsequent result could be a loss of habitat for ice seal species in the Chukchi and Beaufort seas analysis areas.

4.4.1.8.1.7.1. Ringed Seal. Ringed seals will probably be the most severely impacted ice seal species as a result of climate change (AICA, 2004). Moulton (2002) found the highest observed ringed seal densities occurred over areas of shorefast ice with a 10- to 20-m water depth. Reeves (1998) indicated ringed seal presence and use of an area are driven by food availability and ice conditions. In particular, the nearshore areas may see dramatic decreases in ringed seal numbers. Sea ice, particularly shorefast ice, provides a stable denning medium where ringed seals can give birth to their pups, maintain an adequate number of air holes, and use ice edges for haulout spots. However most studies on ringed seals have focused on the shorefast-ice regions, and the value of stable flow ice might not have been adequately investigated (Reeves, 1998). While some authors suggest that landfast ice is the preferred pupping habitat of ringed seals due to its stability throughout the pupping and nursing period (McLaren, 1958; Burns, 1970), others have documented ringed seal pupping on drifting pack ice both nearshore and offshore (Burns, 1970; Smith, 1987; Finley et al., 1983; Wiig, Derocher, and Belikov, 1999; Lydersen et al., 2004).

Either of these habitats can be affected by earlier warming and breakup in spring, which shortens the length of time pups have to grow and mature (Kelly, 2001; Smith and Harwood, 2001). Harwood et al. (2000) reported that an early spring breakup negatively impacted the growth, condition, and apparent survival of unweaned ringed seal pups. Early breakup was believed to have interrupted lactation in adult females which, in turn, negatively affected the condition and growth of pups.

Earlier ice breakups similar to those documented by Harwood et al. (2000) and Ferguson et al. (2005) are predicted to occur more frequently with warming temperatures, and to result in a predicted decrease in productivity and abundance of ringed seals (Ferguson et al., 2005; Kelly, 2001). Additionally, high fidelity to birthing sites exhibited by ringed seals makes them more susceptible to localized impacts from birth lair snow degradation, harvest, or human activities (Kelly et al. 2006). Snow depth on the sea ice, in addition to the timing of ice breakup, appears to be important in affecting the survival of ringed seal pups. Ferguson et al. (2005) attributed decreased snow depth in April and May with low ringed seal recruitment in western Hudson Bay.

Reduced snowfall results in less snow-drift accumulation on the leeward side of pressure ridges; pups in lairs with thin snow roofs are more vulnerable to predation than pups in lairs with thick roofs (Hammill and Smith, 1989; Ferguson et al., 2005). Access to birth lairs for thermoregulation also is considered to be crucial to the survival of nursing pups when air temperatures fall below 0 °C (Stirling and Smith, 2004). Warming temperatures that melt snow-covered birth lairs can result in pups being exposed to ambient conditions and suffering from hypothermia (Stirling and Smith, 2004). Others have noted that when lack of snow cover has forced birthing to occur in the open, nearly 100% of pups died from predation (Kumlien, 1879; Lydersen et al., 1987; Lydersen and Smith, 1989; Smith and Lydersen, 1991; Smith et al., 1991, all cited in Kelly, 2001). More recently, Kelly et al. (2006) found that ringed seal emergence from lairs was related to structural failure of the snow pack, and satellite measurements

indicating liquid moisture in snow. These studies suggest that warmer temperatures have and will continue to have negative effects on ringed seal pup survival, particularly in areas such as western Hudson Bay (Ferguson et al., 2005).

Although the amount of snow in the analysis area is expected to increase, warming temperatures occurring earlier in the spring could result in a decrease in the snowpack depth, affecting ringed seal dens.

Consequently, ringed seal pups would become more exposed to predation and weather events. The end result of increased exposure earlier in the spring is that ringed seal pups could be more easily detected and preyed, or killed by direct exposure to the adverse weather. Another issue facing ringed seals is the effect of melting water on molting ringed seals. Dry skin is essential for ringed seals to molt properly, and so they avoid areas of meltwater for haulout sites, because water will cool their skin, thereby inhibiting the molting process (Moulton et al., 2002).

Ringed seals have been known to dive to depths of 222-340 m, and evidence suggests ringed seal vision plays a very important role in navigation and pilotage under the sea ice (Reeves, 1998). Major behavioral modifications need to occur for ringed seals to adapt to sea-ice losses; these behavioral shifts may include using land-based haulouts, resting, and denning sites (AICA, 2004), diet shifts, etc. Certain populations of ringed seals have been known to use haulouts in areas such as the Okhotsk Sea (Trukhin and Blokhin, 2003; Ognev, 1962); Lake Saimaa; Lake Ladoga; and the Baltic Sea populations and reportedly in the southern end of Admiralty Inlet in Eastern Canada (Reeves 1998). However, AICA (2004) specifically states that the likelihood of ringed seals hauling out on land is very unlikely, because it would be a major deviation from their known behavior.

The last issue related to the effects of sea-ice loss relates to the foraging habits and the diet of ringed seals and how sea ice influences the arctic marine food web. The effects of climate change on fisheries and marine life are covered in Section 4.4.1.4.1.6, and the diet of ringed seals was covered in Section 3.3.6.1.1. Providing the losses of sea ice continue, much of the productivity in the analysis areas could shift to favor fishes over benthos. While ringed seals diets include a large proportion of fish species, including arctic and saffron cod, invertebrates also serve as a major source of nutrition. Ringed seals in these regions are known to shift their diets from one food source to another seasonally, a behavior that reflects food item availability and the ecological interactions between sea ice and the food web. Consequently all of the ice seals may need to reorient their foraging habits to exploit fishes to a higher degree than in the past. Furthermore, any greater reliance on fish stocks might require a greater year-round dependence on existing fish stocks by ringed seals. We expect climate change will have major effects on ringed seals throughout the arctic, to include the Proposed Action area.

4.4.1.8.1.7.2. Spotted Seal. If the expected rate of climate change continues, spotted seal populations may experience the same ecological changes as could other ice seal species. Although they are classified as ice seals, spotted seals are not sea-ice obligate species to the degree that ringed seals or bearded seals are. Spotted seals prefer coastal waters with shallower water depths, particularly after sea ice retreats from the coast. Furthermore they have been known to haul out on land along the Chukchi Sea during summer after sea ice has retreated. Consequently the sea-ice associated impacts of climate change may not affect spotted seals to the same degree as with other ice seal species. During winter, spotted seals prefer areas with leads and expanses of open water; however, during ice-free summers, they spend much time offshore on the shelf feeding, hauling out on land from time to time (Section 3.3.6.1.2).

An advantage that spotted seals have is that they pup on top of the ice, rather than in subnivalian dens. This preference for drifting ice as birthing and pup-rearing habitat more closely resembles projected sea-ice conditions according to AICA (2004). Therefore, the proportionate climate-change associated pup losses among spotted seals should not approach those of ringed seals. Moreover, the fact that spotted seal pups

are born on the ice and in the open means that they are adapted for exposure to the elements from an early age. Consequently, the more extreme weather conditions such as larger, more severe storms could add to bearded seal pup mortality by destroying ice floes and/or forcing the pups into the ocean at an earlier date, as could an earlier breakup with a faster rate of sea-ice melt.

Another issue facing spotted seals is the effect of melting water on ringed seals that are molting. Dry skin is essential for spotted seals to molt properly, and so they avoid areas of meltwater for haulout sites, because water will cool their skin, inhibiting the molting process (Moulton et al., 2002).

The issue of the effects of sea-ice loss to the foraging habits and the diet of spotted seals and how sea ice influences the arctic marine food web was mostly covered in Sections 4.4.1.4.1.6 and 3.3.6.1.4, as were the effects of climate change on fisheries and marine life. Providing the losses of sea ice continue, much of the productivity in the analysis areas could shift to favor fishes, which spotted seals rely on heavily. The ensuing shift from a benthos-rich food base to a fish-rich food base could place many of the ice seal species in direct competition with spotted seals for food resources. We expect climate change should have minor effects on spotted seal populations in the Beaufort Sea and the proposed action area since the projected conditions would more closely mimic those already found along the Chukchi and Bering Sea coastlines where spotted seals occur in much higher numbers.

4.4.1.8.1.7.3. Ribbon Seal. If the expected rate of climate change continues, ribbon seal populations could experience the same ecological changes as other ice seal species. Ribbon seals prefer to live year-round near the edge of the pack-ice. Also they dive to depths of 200 m, indicating their preferred water depth is <200 m.

Like bearded and spotted seals, ribbon seals produce their pups on pack ice in April-May and wean the pups within 3 or 4 weeks. After the weaning period, ribbon seal pups spend most of their time on the ice, learning how to swim and dive in the ocean so that they develop the skills to survive on the pack-ice fringe. Frost and Lowry (1986) found that like spotted seals, the diet of the ribbon seal in the northern Bering Sea is composed mostly of fish, particularly arctic cod. Consequently the sea-ice associated impacts of climate change may not affect ribbon seals to the same degree as with other ice seal species. They prefer to live on and around the fringe of sea-ice having leads and open water immediately available. They seem to seasonally follow the progression and recession of the pack-ice fringe. Ribbon seals have been observed diving to a maximum depth of 200 m; however, considering that their primary food source is fish and not the benthos, they may not be restricted to shallow coastal areas (Section 3.3.6.1.3).

Similar to bearded and spotted seals, ribbon seals prefer to give birth on the pack-ice fringes near open water. This preference for using pack-ice as a birthing platform and pup-rearing habitat by ribbon seals more closely resembles the projected sea-ice conditions, according to AICA (2004), in the recession of sea ice northwards from the coastline, particularly in the analysis area. Consequently, the proportionate climate-change associated pup losses among ribbon seals should not approach those of ringed seals. Moreover, ribbon seal pups are adapted for being born on the sea ice, fully exposed. Accordingly more extreme weather conditions such as larger, more severe storms could add to ringed seal pup mortality by destroying icefloes and/or forcing the pups into the ocean at an earlier date, as might an earlier breakup with a faster rate of sea-ice melt.

Another issue facing ribbon seals is the effect of melting water on moulting. Dry skin is essential for ribbon seals to molt properly, and so they avoid areas of meltwater for haulout sites, because water will cool their skin, inhibiting the molting process (Moulton et al., 2002).

The issue of the effects of sea-ice loss to the foraging habits and the diet of ribbon seals, and how sea-ice influences the arctic marine food web was mostly covered in Sections 4.4.1.4.1.6 and 3.3.6.1.3, as were the effects of climate change on fisheries and marine life. Providing the losses of sea ice continue, much of the productivity in the analysis areas could shift to favor fishes, which ribbon seals rely on heavily (Frost and Lowry, 1986). The ensuing shift from a benthos-rich food base to a fish-rich food base may place other ice seal species in direct competition with ribbon seals for food resources. With the expected decrease in sea ice and the increase in open water habitat we anticipate an increase in ribbon seals in the Beaufort Sea as this species shifts part of its range northwards. Furthermore this species is not as ice-dependent as are ringed seals, spending much of its time in the pelagic environment. Consequently the changing climate may have a positive influence on ribbon seals in the Beaufort Sea with a minor level of effect.

4.4.1.8.1.7.4. Bearded Seal. If climate change continues to occur at projected rates, bearded seals would experience the same environmental changes as ringed seals. Due to behavioral and physiological differences between ringed seals and bearded seals, the effects of the changing climate are likely to impact bearded seals with less severity. Bearded seals prefer sea-ice areas with leads and expanses of open water, and it is this habitat preference that could lessen the impact of sea-ice losses on this species (Section 3.3.6.1.4).

While bearded seals normally are associated with sea ice, they do not seem to depend on shorefast ice as their preferred habitat. Bearded seals prefer the edges of the ice pack offering areas of open water. During summer, they seem to prefer open-water nearshore areas with depths of ≤ 200 m; however, during winter, they often forage on ice-dependent organisms and so can use areas with water depths > 200 m. Consequently, while the bearded seal population should take some losses associated with the effects of sea-ice loss, the fact that they can use ice packs over deeper waters, and that they have a large amount of flexibility in their diet, may allow them to retain some level of viability as a species as ice conditions and prey availability change.

Another advantage that bearded seals have is that they pup on top of the ice, rather than in subnivalian dens on shorefast ice. This preference for drifting ice as birthing and pup-rearing habitat more closely resembles projected sea-ice conditions according to AICA (2004). Therefore, the proportionate climate-change associated pup losses among bearded seals should not approach those of ringed seals. Moreover the fact that bearded seal pups are born on the ice and in the open means they are adapted for exposure to the elements from an early age. Consequently, the more extreme weather conditions such as larger, more severe storms could add to bearded seal pup mortality by destroying icefloes and/or forcing the pups into the ocean at an earlier date, as could an earlier breakup with a faster rate of sea-ice melt.

Another issue facing bearded seals is the effect of melting water on molting. Dry skin is essential for bearded seals to molt properly, and so they avoid areas of meltwater for haulout sites, because water will cool their skin, thereby inhibiting the molting process (Moulton et al., 2002).

The issue of the effects of sea-ice loss to the foraging habits and the diet of bearded seals and how sea ice influences the arctic marine food web was mostly covered in Sections 4.4.1.4.1.6 and 3.3.6.1.4, as were the effects of climate change on fisheries and marine life. Providing the losses of sea ice continue, much of the productivity in the analysis areas could shift to favor fishes over benthos, which bearded seals rely on heavily. While the diet of bearded seals indicates they have the potential for making the necessary adjustments in their diet, the ensuing shift from a benthos-rich food base to a fish-rich food base could place many of the ice seal species in direct competition with one another for food resources. We anticipate climate change to have moderate effects on bearded seals considering their varied habitat and diet preferences.

4.4.1.8.1.7.5. Pacific Walrus. Loss of sea ice over the Continental Shelf is expected to have major impacts on walrus habitat use. These impacts include limiting access to preferred feeding areas, increasing energy expenditures, increasing risk of predation, and increasing the risk of trampling during stampedes caused by disturbance events at coastal haulouts. Walrus consume more than 3 million metric tons of benthic biomass annually. There is evidence that walrus feeding affects the level of productivity of the seas that they inhabit (Ray et al., 2006). Typically, walrus remain on the sea ice as long as it remains over the continental shelf, and retreat to land-based haulouts when the ice edge moves off the edge of the shelf into deep water. Born et al. (2003) found that walrus in Greenland spent more than half of their dive time in waters 6-32 m deep. Ray et al. (2006) found that walrus feeding bouts result in structural alterations of the benthic environment and potentially affect not only the benthic environment, but Beringia as a whole. If walrus become concentrated in particular nearshore areas due to proximity to accessible coastal haulout habitats, it may have profound effects locally and throughout Beringia.

Loss of sea ice cover is having profound effects on walrus. Changes in their distribution and use of land-based haulouts are increasingly apparent. These changes are most apparent in the Chukchi Sea. For a thorough discussion of the effects from these changes in the physical environment to walrus, see Section 4.5.1.8.3.2.7.

4.4.1.8.1.7.6. Beluga Whale and Other Toothed Whales. More than 40 exploration-drilling units (gravel islands, drillships, and other platforms) have been installed or constructed in the Beaufort Sea as a result of past Federal and State oil and gas leases. Several million cubic yards of gravel and dredge-fill material have altered at least a few square kilometers of benthic habitat in the Beaufort Sea. Alterations from island construction, trench dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 km for <1 year or season. These activities also may temporarily affect the availability of some local food sources up to 1-3 km (0.62-1.9 mi) distance during island construction. These activities are not expected to affect food availability over the long term for the following reasons:

- Common prey species for belugas, such as arctic cod, have a very broad distribution and would not suffer from the fractional loss of benthic habitat associated with platforms and pipelines.
- Toothed whales can forage over large areas of the Beaufort Sea; they do not rely exclusively on the abundance of local prey.
- Gravel islands used for oil production may provide habitat for some prey species. They are not likely to affect the availability toothed whale prey in the Beaufort Sea.

In recent years in the Beaufort Sea, the edge of polar ice has retreated much farther north in summer (Laidre et al., 2008). How the destruction or alteration of sea ice will affect the distribution, disappearance, or extinction of ice-dependent species is unpredictable. For narwhals, the most specialized of Arctic cetaceans and the species that occupies the densest winter sea ice longer than any other, the effects may be more pronounced than for other toothed whales. Should killer whales range farther into Arctic waters, their predatory impact on other marine mammals likely will increase. Beluga whales are capable of surviving for extended periods far from sea ice. It is unclear why belugas move into ice; however, it is possible, although not proven, that they move into offshore ice to prey primarily on arctic cod. How a loss of sea ice might affect beluga predation on Arctic cod is unclear.

Recent changes in the Arctic have not yet contributed to detectable changes in subsistence harvest of belugas. As the ice edge recedes farther north, how this environmental change will affect belugas migration, distance to shore, and hunter access coincident with a reduced and possibly less stable sea ice platform is unknown.

Indirect effects from warming trends in the Arctic include potential effects from increased noise exposure and collision potential related to increases in vessel traffic and development activities in response to increased open-water area, emerging commercial opportunities and routes, and operational time period. Potential increased effects of commercial fisheries, including noise and disturbance, gear entanglement, prop strikes, and collisions.

4.4.1.8.1.7.7. Gray Whale. Gray whale habitat loss may occur in local areas of intensive human activities in nearshore feeding areas of the Beaufort Sea. Effective use of feeding habitats may be decreased due to noise and human activities, causing avoidance of such areas. Exploration activities could cause temporary avoidance and displacement from feeding areas and, if development should occur, localized feeding sites may be avoided by gray whales where longer term facilities and operations occur in shallow coastal and shoal feeding areas. Natural fluctuations in gray whale abundance can be expected as the population, which is thought to be close to or at carrying capacity (Moore et al., 2001), adjusts to natural and human-caused factors affecting carrying capacity. Depletion of local and regional prey abundance by gray whales in the northern Bering Sea has been correlated with calf production of gray whales (Perryman et al., 2002). Effects of arctic warming on Beaufort Sea gray whale distribution and habitat is uncertain and would be speculative at this time.

Changes in the physical environment of the Arctic appear to be most influenced by the warming trends experienced in recent decades. Trends imply the warming phenomena and resultant changes in oceanographic processes and temporal and spatial sea-ice distribution are likely to continue. Implications of arctic warming on gray whales cannot be predicted with any precision, but changes are indicated. This section briefly describes likely ongoing effects of changes in oceanographic processes and ice distribution on baleen whales in the Arctic.

4.4.1.8.2. Mitigation Measures. Some aircraft in coastal areas are restricted, particularly those flights associated with MMS-authorized activities. The MMPA does not specifically restrict aircraft height AGL, but it does require that individuals, vessels and aircraft not disturb marine mammals. Any aircraft or vessel that approaches and disturbs any marine mammal is in violation of the Act, and could be subject to prosecution or fines. The FWS recommends that pilots avoid hauled out walrus by a minimum of 0.5 km horizontal distance and remain at a minimum height of 1500 ft AGL. The NMFS has similar recommendations for haul outs and whale species.

Mitigation measures imposed under the no-action alternative would be those measures already in place under pre-existing lease sales. See the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a) for the specific mitigation measures imposed.

Mitigation Stipulations and Measures for Seismic Operations. The standard stipulations included in MMS-permitted geological and geophysical (G&G) activities are provided in Appendix K. On-lease ancillary seismic activities would use a selected suite of these measures that are appropriate for the specific operation:

The proposed lease stipulations include one for Orientation Programs, which requires all personnel involved in petroleum activities on the North Slope as a result of the proposed lease sale to be aware of the unique environment and social and cultural values of the area.

Mitigation also is provided by several ITLs and NTLs (See Section 2.2 and Appendix F), such as Information on Bird and Marine Mammal Protection and Information on Discharge of Produced Waters. This first ITL advised lessees that during the conduct of all activities the lessee will be subject to the MMPA. Further, this ITL encouraged lessees to “exercise particular caution when operating in the

vicinity of species whose populations are known or thought to be declining and which are not protected under the ESA; such as, Pacific walrus.” Disturbance of marine mammals could be determined to constitute a “taking” under the Act. The ITL on produced waters advised lessees that the State of Alaska prohibits discharges of produced water on State tracts within the 10-m depth contour.

4.4.1.8.3. Anticipated Effects Under Alternative 1. Effects under this alternative are separated into direct and indirect effects (Section 4.4.1.8.3.1) and cumulative effects (Section 4.4.1.8.3.2).

This section describes the impact to marine mammals resulting from the incremental impact of the action (which for this alternative is taking no action) and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Past and present actions are described in Section 3.3.6. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures (described in Section 4.4.1.8.2) and the following important factors are considered in determining the anticipated effects from this alternative.

Timing. The window of time for exploration typically includes the open-water period. For production, operations would take place year-round, and effects would be possible from a variety of sources throughout the year.

Residence Time and Periodicity. Effects vary based on whether activity in the area is short term or long term, and whether it involves passage through an area on a frequent or intermittent basis. During exploration, drillships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft likely would need to make trips between the drillship and shore to deliver personnel and equipment. Residence time and periodicity of drillships and support vessels during exploration could vary; levels of effect could vary, depending on location and timing.

Spatial Extent. The lease-sale area is large, and the area explored in any given season is small by comparison. Beyond the footprint of a seismic vessel or drillship, consideration must be given to the area affected by noise, support-vessel traffic, and other secondary factors.

Oil Spills. We recognize that if a large oil spill occurred where there were concentrations of marine mammals, large-scale mortality could occur, representing a major population-level effect. Large spills could arise from a variety of sources, especially during bulk fuel deliveries or other marine accidents. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4.

Extent of mortality that could result from oil spills from oil production (currently viewed as being speculative until a large, commercially developable field is discovered) is extremely difficult to estimate. First, it is uncertain that oil would ever be discovered. The potential that a commercial field would be discovered in the Chukchi Sea is $\leq 10\%$ and about 20% in the Beaufort Sea. Secondly, it also is uncertain that oil would be spilled. As stated in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), the likelihood of one or more large spill of at least 1,000 bbl (42,000 gal) during the life of the project was estimated to be 8-10%. The multiple-sale EIS and the Sale 195 EA (USDOJ, MMS, 2004) explain that the occurrence estimate includes only part of the variability in the Arctic effects on the spill rate. During Fiscal Year 2004, MMS procured the study titled Improvements in the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas. The study included the non-Arctic variability of spill frequency and spill size. An implication from this study is that the chance of one or more large spills increased from 8-10% (USDOJ, MMS, 2003a:Section IV.A.4.a (1)) to 21% for Sale 202. The extent of mortality from such an improbable spill would be greatly influenced by the location, volume, trajectory, and timing, as well as the period that oil remains in the environment.

Following production, a larger number of small spills (<1,000 bbl) could occur, but most of these would be into containment (not the open ocean). In addition, the low chance of one or more large oil spills occurring, combined with the uncertainty of the location of the spill, make it highly unlikely that numerous, chronic, small spills or a large oil spill would contact large numbers of marine mammals. For example, 68,000 gal of heating oil were reportedly spilled into the Beaufort Sea near Kaktovik in 1988. No oiled birds or other wildlife were discovered, and the USCG closed the case.

The MMS requires companies to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment. For purposes of analyses, numerous small spills or large spills from OCS oil and gas activities are considered high-effect, low likelihood events and are not considered reasonably foreseeable.

For the same reason, it is difficult to estimate the potential for chronic small spills or a large spill to originate from private, commercial, or State sources within the Chukchi or Beaufort seas. Increasing vessel traffic in general and bulk fuel deliveries in particular, appear to present some danger of an oil spill.

The following analysis describes the anticipated effects that would occur if MMS does not hold any additional sales in the Beaufort or Chukchi seas under the current 5-Year Program. As there would be no direct or indirect effects from this alternative in the project area, the anticipated effects are the only effects, and as such, are the cumulative effects for this alternative. In the analyses for each of the other alternatives, the cumulative effects from this alternative will be combined with the anticipated direct and indirect effects from each of the remaining sale alternatives to determine the cumulative effect for that alternative.

The level of effect terms are defined as having the following characteristics.

Negligible effects include localized short-term disturbances or habitat effects that are not expected to continue across multiple seasons. No mortality or impacts to reproductive success or recruitment are anticipated. Mitigation measures are implemented fully and effectively or are not necessary.

Minor effects include localized chronic disturbances, widespread, short-term disturbances, and habitat effects that may persist over time, but are localized to a small area. No adult mortality is expected, although some short-term impacts to the reproductive success of a few individuals or to recruitment may occur. Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Those adverse effects that are unavoidable are short term and localized.

Moderate effects include impacts that are widespread and that may affect more than a few individuals, such as chronic disturbances at key locations or habitat effects that persist for multiple years. Direct mortality of a few individuals may occur; or direct mortality is not anticipated, but ongoing disruption to behavior patterns or important habitat may have high energetic or reproductive or recruitment costs that have the potential to negatively affect the population over time. Widespread implementation of mitigation measures for similar activities likely would be effective in reducing the level of avoidable adverse effects. Un-mitigatable or unavoidable adverse effects are short term but widespread, or are long term and localized. For whales, the number of affected individuals would not exceed an approximate PBR. The NMFS defines the PBR as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor.

Major effects include widespread annual or chronic disturbance, habitat effects experienced during one season that would be anticipated to persist for decades, or widespread effects to reproductive success or recruitment. Anticipated or potential mortality could produce a population-level effect. Widespread implementation of mitigation measures could be effective in reducing the level of avoidable adverse effects. Un-mitigatable or unavoidable adverse effects are widespread and long lasting. For whales, mortality might occur above the estimated PBR.

4.4.1.8.3.1. Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts to marine mammals under Alternative 1, the no-action alternative. A lack of direct or indirect effects means that there would be no incremental contribution under this alternative to cumulative effects.

4.4.1.8.3.2. Cumulative Effects Under Alternative 1. The cumulative impacts under the no-action alternative are based on the existing natural environment and current anthropogenic ongoing actions in the Beaufort Sea. Primary considerations for marine mammals include the anticipated environmental changes that are anticipated to have major impacts to marine mammals, even if none of the lease sales are held.

4.4.1.8.3.2.1. Anticipated Level of Effect from Underwater Noise. There are four sources of anthropogenic noise in the Alaskan Arctic: (1) vessel-traffic noise, (2) aircraft noise, (3) seismic-survey noise, and (4) exploration and production drilling noise.

4.4.1.8.3.2.1.1. Vessel Traffic Noise. Section 3.1.3.2 describes the general past and present vessel-traffic patterns in the Beaufort Sea. Existing information indicates an increasing amount of vessel traffic, particularly in tourism and research vessels in the Arctic. There is also a high level of interest in using the Northwest Passage as a shipping route to decrease the distance ships would have to travel between the Pacific and the Atlantic oceans. Increasing military activities also are anticipated. We anticipate these trends to continue into the reasonably foreseeable future.

Ringed, Spotted, Ribbon, and Bearded Seals. Vessel traffic in the Proposed Action area is expected to increase in the foreseeable future in support of existing and speculative oil and gas activities. While new vessel traffic could disturb ice seals, particularly ringed seals, no additional vessel traffic should develop under Alternative 1. Consequently no additional noise from vessels should result under Alternative 1. Vessel noise under Alternative 1 is anticipated to impact ice seals with a negligible level of effects.

Pacific Walrus. Vessel traffic in open water is unlikely to have a more than negligible impact to walrus. An increase in icebreaker traffic could disturb walrus and potentially disrupt movement patterns or displace walrus from preferred foraging areas. However, the majority of the walrus population remains in the Chukchi Sea and are unlikely to be affected by vessel activities in the Beaufort Sea. Vessel noise under Alternative 1 is anticipated to result in negligible impacts to walrus.

Beluga Whale. Beluga response to icebreaker noise usually is avoidance. Increased use of icebreakers over an expanding region of activity could expose more toothed whales to more frequent short-term exposure to noise potentially earlier and later in the ice-associated period of the year. Drillships often are attended by an icebreaker in the late fall as ice forms and assists in prolonging the drilling season. It is reasonable to anticipate that oil and gas exploration activities in the Canadian Beaufort Sea may use the support of icebreakers. Icebreakers often are the primary research vessels, and icebreakers attend other vessels in transit during early portions of open-water periods and during the spring beluga whale

migration through the spring lead system. These vessels would be relatively free to navigate in areas where disturbance to beluga whale concentrations of cows and calves could occur in the Beaufort lead systems. An increase in vessel traffic is anticipated to occur for the same reasons as icebreaker activity trends, and involves increases tourism, research, military, and commercial-vessel traffic and supply-fuel barges to villages. More frequent encounters with toothed whales are likely to occur where whale habitats overlap vessel-travel corridors.

Gray Whale. More frequent encounters with gray whales are likely to occur where whale habitats overlap vessel-travel corridors. A negligible level of effects to gray whales is anticipated..

4.4.1.8.3.2.1.2. Aircraft Noise.

Ringed, Spotted, Ribbon, and Bearded Seals. Spotted seals have been documented to panic when approached by aircraft as have ringed and bearded seals (Richardson 1995; Burns and Harbo 1972). The expected increase in aerial flights in the Proposed Action area is expected to produce negligible levels of effects on ice dependent seals. No additional aircraft activity or noise could be expected to occur under Alternative 1. Aircraft noise is expected to have a negligible level of effect on ice seals.

Pacific Walrus. Most aircraft on the North Slope are operated without altitude or route restrictions for safety reasons. The MMPA requires pilots to avoid disturbing walrus at sea or at coastal haulouts; however, many pilots are unaware of the detrimental effects of flying at low levels over walrus haulouts. Some traffic associated with State oil and gas operations in and south of the Beaufort Sea is restricted to protect certain species, and these restrictions also may benefit walrus (ADNR, 2008) but, as there are no State oil and gas operations in the Chukchi Sea, such protections are not in effect. Frequent low-level flights associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact walrus at coastal haul outs. As walrus haul out more frequently along the Chukchi Sea coast, unrestricted aircraft activity could result in a minor to moderate level of effect. Any adverse effects are anticipated to continue.

Beluga Whale. Richardson et al. (1995a) suggest that airborne sounds (and visual stimuli) from aircraft may be less relevant to toothed whales than baleen whales, but reactions are variable. For example, beluga responses in offshore waters near Alaska ranged from no overt response to abrupt diving and avoidance, and generally increased with decreasing flight altitude. Reactions to aircraft include diving, tail slapping, or swimming away from the aircraft track. In other cases, both baleen and toothed whales showed no reaction to aircraft overflights. In summary, responsiveness depends on variables, such as the animal's activity at the time of the overflight or altitude level of aircraft, and most animals quickly resume normal activities after the aircraft has left the area. Richardson et al. (1995a) state that there is no indication that single or occasional overflights can cause long-term displacement of cetaceans.

Gray Whale. Richardson et al. (1995a) suggest that airborne sounds (and visual stimuli) from aircraft may be less relevant to toothed whales than baleen whales, but reactions are variable. Gray whale mother-calf pairs seem to be sensitive, while migrating gray whale responses are not as detectable. In other cases, both baleen and toothed whales showed no reaction to aircraft overflights. In summary, responsiveness depends on variables, such as the animal's activity at the time of the overflight or altitude level of aircraft, and most animals quickly resume normal activities after the aircraft has left the area. Richardson et al. (1995a) state that there is no indication that single or occasional overflights can cause long-term displacement of cetaceans.

4.4.1.8.3.2.2. Anticipated Level of Effect from Seismic-Survey Noise. There are existing Federal leases in OCS portions of the Beaufort Sea, and it is expected that leaseholders and others would conduct 2D/3D seismic surveys to evaluate the potential for oil and gas production in the future. These surveys would primarily occur during the open-water period. Some on ice surveys would occur in shallow near shore areas. Similarly, State leases occur and are proposed in the State waters of the Beaufort Sea as well as exploration activities in the Canadian Beaufort Sea. It is reasonable to expect similar seismic-survey activities in the future. There are existing State leases in State waters, Federal leases in OCS portions of the Beaufort Sea, and exploration licenses in the Canadian Beaufort Sea. It is expected that leaseholders and others would conduct high-resolution seismic surveys to evaluate State waters and the OCS for oil and gas exploration drilling, development, and production in the future. If potential commercial deposits are indicated, localized high-resolution seismic surveys would be expected to increase, as leaseholders evaluate and plan specific exploration, development, and production actions. High-resolution surveys would be expected to decline in localized areas, as production and transport facilities are completed.

Ringed, Spotted, Ribbon, and Bearded Seals. Most impacts from seismic activity should be brief. While ringed seals have been known to abandon their dens at times during vibroseis, other ice seals have different responses to seismic activity. Seismic surveys are unlikely to have large-scale impacts (e.g., masking) on vocalizations associated with breeding activity due to the time of year that surveys would occur (i.e. after the breeding season). Literature indicates seismic projects in the Beaufort analysis area would result in only short-term impacts to ice seals. No additional seismic activity would result under Alternative 1. Consequently, we expect a negligible level of effects on ice seals under Alternative 1.

Pacific Walrus. Ongoing exploration by on ice and open water seismic surveys are occurring on areas leased by MMS in the Beaufort Sea during Lease Sales 186, 195, and 202. In addition, seismic surveys are also taking place off lease. Effects from seismic activity are expected to be minor due to mitigation measures currently in place, and because few walrus occur in the Beaufort Sea. According to existing LOAs, seismic operators must have a marine mammal observer on board and must shut down operations if a walrus is observed within the 190 db safety zone. There is very little information on the specific effects of seismic activities on walrus hearing or behavior. Walrus may be affected by seismic surveys through effects on their hearing, disturbance from preferred areas, or in some cases may be drawn to seismic ships during open-water surveys. Some walrus may be temporarily displaced, but these effects are expected to be short term and sublethal. Impacts of seismic survey activities to walrus in the Beaufort Sea are anticipated to be negligible.

Beluga Whale. Ongoing open water seismic surveys are occurring on and off areas leased by MMS in the Beaufort Sea during Lease Sales 186, 195, and 202. Continuation of 2006 and 2007 levels of OCS 2D/3D seismic surveys likely would continue. These surveys are subject to MMS-imposed mitigation measures to avoid or minimize adverse effects to toothed whales in the Beaufort Sea. Negligible effects are anticipated from existing levels of 2D/3D seismic surveys. The MMS-permitted post-lease high-resolution surveys in the Beaufort Sea are expected to increase as potential prospects are investigated for oil and gas production potential and subsequently developed and produced. These surveys are subject to specific MMS-imposed mitigation measures to avoid or minimize adverse effects to toothed whales in the Beaufort Sea from multiple activities that collectively could affect beluga whale movement, foraging, seasonal migration, and subsistence-harvest opportunity.

Gray Whale. Continuation of 2006, 2007 and 2008 levels of OCS 2D/3D seismic surveys likely would continue relative to previous lease sales. These surveys are subject to MMS-imposed mitigation measures to avoid or minimize adverse effects to gray whales in the Beaufort Sea. Negligible level effects to gray whales are anticipated from existing OCS levels of 2D/3D seismic surveys. State leases occur and are

proposed in the State waters of the Beaufort Sea. It is reasonable to expect a continuation of similar levels of seismic-survey activities in the future. State of Alaska seismic activities are subject to mitigation measures and other conditions to avoid or minimize adverse effects on gray whales. Minor level effects to some individual gray whales are anticipated.

4.4.1.8.3.2.3. Anticipated Level of Effects from Exploration and Production Drilling Noise.

Some exploration and production drilling are ongoing on Federal and State leases in the Beaufort Sea. State leases occur within 3 mi of shore. Drilling noise and anticipated effects are similar regardless of whether the lease is State or Federal.

Ringed, Spotted, Ribbon, and Bearded Seals. Richardson (1995) noted that ringed seals often frequent drillships working in the arctic, and that ringed and bearded seals exhibit some level of tolerance to drilling ships and equipment. Moulton et al. (2003) found that ringed seal densities were not reduced in the vicinity of the Northstar project in the Beaufort Sea. Kelly, Burns, and Quakenbush (1988) found that industrial noise caused 4% of ringed seals to abandon their lairs and breathing holes in undisturbed fast ice, while 13.5% abandoned their holes in disturbed fast ice areas. Exploration and production noise is not expected to produce a disturbance exceeding the tolerances of adult ice seals. Consequently, ongoing exploration and production noise is expected to produce a negligible level of effects to ice seal populations in the Proposed Action area, which lies offshore and away from most fast ice. Moreover, no new exploration or production activities or noise should result under Alternative 1.

Pacific Walrus. The noise associated with drilling may displace some walrus from the immediate area. Given current levels of activity and the current distribution of walrus, the effects of this displacement are likely to be negligible in the Beaufort Sea.

Beluga Whale. The current levels of State nearshore petroleum exploration, development and production; increased production from planned development of commercial petroleum discoveries; and continued production activity of the OCS Northstar facility and Liberty development is anticipated. Existing monitoring data indicate minor effects on toothed whales are anticipated from these activities. Effects to beluga whales are unknown at this time.

Gray Whale. Continued production activity of the OCS Northstar facility is anticipated and the shore based Liberty development is expected to occur. For exploration drilling, up to two drilling operations may operate simultaneously in the Beaufort Sea. These may drill at more than a single location in a given year; however this level of activity is not greater than is currently operational and would not contribute more disturbance than current allowed levels. These may drill at more than a single location in a given year. Exploration drilling likely would involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible for exploration and if development and production is pursued. Effects from drilling operations can cause slight deflection of some whales from original travel routes; however, the deflection is transitory after passage of a drillship or platform. Synergistic adverse effects as a result of multiple localized activities including platform placement and construction, drilling, seismic survey and other concurrent activities are avoided or minimized by application of mitigation measures that avoid or minimize the footprint of multiple activities relative to one another and to the gray whale biological activities and movement. Localized prey concentrations may in part be locally avoided by some whales when in close proximity to active drilling operations; however, gray whales, like bowhead whales, may tolerate noise when motivated to feed in such areas. Similar tolerance responses of gray whales under similar circumstances are uncertain. It is unknown whether tolerating higher level noise exposure in high-concentration feeding areas results in TTS (no tissue damage, but temporary reduction in hearing sensitivity) or PTS (resulting in tissue damage and

permanent loss of hearing sensitivity) in gray whales. Some individuals could experience TTS or PTS, but it is uncertain at this time.

A negligible level of effect is anticipated with appropriate mitigation measures in place (e.g., marine mammal observers, safety zones, and shutdown procedures) and the probability of seismic-survey-generated injuries should be mitigated.

4.4.1.8.3.2.4. Anticipated Level of Effect from Vessel and Aircraft Disturbance. The potential effects from vessel and aircraft presence to marine mammals were described in Section 4.4.1.8.1.2. Some of these disturbances may also have been covered under the section on underwater noise from vessels and aircraft, but this section covers the physical presence of vessels and aircraft or associated above-water noise. Icebreakers, in particular, can enter ice-covered areas where pinnipeds are hauled out on the ice. The potential for vessels striking marine mammals (vessel strikes) was not considered an important source of injury or mortality.

4.4.1.8.3.2.4.1. Effects from Vessels. Most vessels operating in marine areas of the Beaufort Sea are operated without speed or route restrictions. Vessel traffic associated with shipping, intercommunity travel, hunting, research studies, and oil and gas operations likely affect marine mammals and any adverse effects are anticipated to continue. Effects from vessel activity that is not subject to MMS mitigation requirements would continue in nearshore areas providing habitat for ice seals, walrus, and whales.

Ringed, Spotted, Ribbon, and Bearded Seals. Activity from icebreakers associated with ice-management for exploration drilling may pose a low threat to ringed seals. Ringed seal pups living in dens usually have a sufficient number of dens located nearby, where they can retreat to if disturbed by ice-breaking activity. Reeves (1998) stated that ringed seals have been killed by icebreakers moving through fast ice. Positive effects of icebreaker activity stem from the creation of new leads and openings in the ice. In these areas, ice seals can hunt, rest, and build new dens as conditions permit. Implementation of this alternative should have no effect on ribbon seal populations since they are rare visitors to the Beaufort Sea. Bearded and a small number of spotted seals occur in the Beaufort Sea sale area, typically using the edges of the ice front as a platform for resting and birthing.

The Proposed Action area lies offshore and away from any fast-ice habitat. Furthermore no additional vessel activity is expected to result under Alternative 1. Consequently, ice seal species (ringed seals in particular) are believed to experience moderate levels of impacts from ongoing vessel activities in the proposed action area. Under Alternative 1, vessel traffic is expected to have a negligible level of effect on ice seals.

Walrus. Vessels operating in the Beaufort Sea may displace small numbers of walrus, but they are unlikely to have more than negligible impacts to walrus.

Beluga Whale. Exploration drillship activity likely would increase from zero to two in the Beaufort Sea to explore existing OCS leases. These may drill at more than a single location in a given year; however this level of activity is not greater than is currently operational and would not contribute more disturbance than current allowed levels. These likely would be attended by an icebreaker-class vessel in the late fall. Icebreakers attending drillships often mask the operating drillship noise when active. Seismic and support vessels would occur a near current levels. These would be localized sources of noise that migrating belugas would avoid and potentially deflect from normal migration corridors. The effect would be short term and not have population-level effects. The MMS-required mitigation measures would avoid or minimize the effect of such activity on spring and fall beluga whale migration so as to not interfere with the traditional availability of belugas for subsistence hunts or concentrations of vulnerable cows and

calves in the spring lead system. Similar mitigation would be applied should delineation and production wells be developed. As a result, MMS-authorized vessel activity would have proportionately fewer impacts to beluga whales than unrestricted vessel operations. Anticipated effects could result in the injury or mortality of a few individual toothed whales as result of vessel-whale contact. Level of noise-related effects is anticipated to be minor.

Gray Whale. The vessel-related post-lease (existing Lease Sales 186, 195, and 202) activities (see the previous section on beluga whales) likely would increase incrementally in the Beaufort Sea; however, MMS-imposed mitigation measures on vessels associated with oil and gas exploration and development activities avoid or minimize effects upon endangered whales. As a result, MMS-authorized vessel activity would have proportionately fewer impacts to gray whales than unrestricted vessel operations. Anticipated effects could result in the injury or mortality of a few individual minke or gray whales as result of vessel-whale contact. The noise-related level of effects are anticipated to be minor.

4.4.1.8.3.2.4.2. Effects from Aircraft. Most aircraft on the North Slope are operated without altitude or route restrictions. Frequent traffic associated with freight, intercommunity travel, research studies, and oil and gas operations likely impact marine mammals, but at an unknown level. Any adverse effects are anticipated to continue. Effects from aircraft activity that is not subject to MMS mitigation requirements would continue in nearshore areas providing habitat for ice seals, walrus, and whales and that are subject to low-level overflights serving a wide variety of non-OCS activities.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects from air traffic to ice seals in the Proposed Action area are very localized and brief. Some groups of ice seals are occasionally disturbed from their haulouts and enter the water, although their responses are highly variable. Foreseeable levels of aircraft traffic in the Proposed Action area are expected to have negligible levels of effect on ice seals, and no additional aircraft traffic is expected to occur under Alternative 1.

Pacific Walrus. Existing effects from aircraft traffic and associated noise are difficult to assess, but are anticipated to result in continued effects on walrus. Aircraft traffic and associated noise could adversely affect walrus by: (1) displacing walrus from terrestrial haul outs during much needed resting periods; (2) disturbing walrus on icefloes; (3) causing stampedes which lead to injuries and death for adults and calves; (4) causing walrus to abandon haul out areas prematurely; (5) disrupting movements onshore and offshore; and (6) causing heat stress and/or unnecessary energetic expenditures. While some walrus tolerate noise and activity in close proximity, others do not. Females with calves are particularly susceptible to impacts from disturbance events. Individual tolerances are expected to vary, however, and the intensity of disturbance also varies.

The level of impact depends entirely upon the frequency and intensity of the disturbance events, and these are undocumented in most cases. The FWS continues to try to educate the public, particularly pilots, about the serious adverse effects of disturbance events. If these public education efforts are successful, then these impacts may decrease in spite of increases in aircraft traffic. Any impacts in the Beaufort Sea are likely to be negligible given the current distribution of walrus.

Beluga Whale and Gray Whale. Aircraft traffic serving a wide variety of non-OCS activities is anticipated to continue in coastal areas of the Beaufort Sea. Unrestricted, low-level flights would continue to harm beluga and gray whales in nearshore areas. These unrestricted activities are anticipated to result in no more than minor effects on beluga and gray whales.

Oil- and gas-related aircraft traffic supports exploration, development, and production phases on existing leases in the Beaufort Sea OCS. Authorized aircraft operations are required to avoid disturbing walrus at

terrestrial haulouts and a negligible level of effect from MMS-authorized activities on pinnipeds is anticipated. Similarly, mitigation measures imposed on exploration and development activities minimize adverse effects to belugas and gray whales in the Beaufort Sea and a negligible level of effect on beluga and gray whales from MMS-authorized activities is anticipated.

4.4.1.8.3.2.5. Anticipated Level of Effect from Subsistence.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects from subsistence activities to ice seals in the Proposed Action area are very localized and brief. Sections 3.4.2.2 and 4.4.1.12 provide greater insight into the annual harvest of northern ice seals by subsistence hunters in the Proposed Action area. Overall, subsistence hunting is anticipated to produce a moderate level of effect on ringed, spotted, and bearded seals in the Beaufort Sea sale area.

Pacific Walrus. We anticipate that subsistence take of walrus in the Beaufort Sea will continue to be managed by the FWS, the Eskimo Walrus Commission, and the Association of Marine Mammal Hunters of Chukotka. If walrus numbers decline in relation to the decline in sea ice, the subsistence take may also decline. This may happen naturally as walrus become less accessible due to lower numbers, or through agreements between the managing bodies. It is also possible that an increase in the numbers of walrus remaining onshore near human habitation, or an increase in the duration of time that walrus spend onshore, and a decrease in the availability of other marine mammal species may lead to an increase in walrus take. The long term sustainability of a continued walrus harvest would depend upon maintaining good information on the walrus population level and good cooperation among the managing bodies.

Beluga Whale. The harvest of belugas for subsistence purposes would remain the largest known human-caused mortality and is expected to continue at the current levels until 2012, at which time subsistence harvest quotas may be revisited by the IWC. This harvest is anticipated to continue to have a moderate level of effect on beluga whales. Authorized activities are not likely to contribute to a change in the subsistence activities and the harvest of non-ESA-listed marine mammals in the Beaufort Sea. Required mitigation measures and conditions of IHA/LOA from NMFS/FWS on exploration or potential development activities would ensure marine mammal movement into harvest areas, subsistence-hunting activities, and opportunity to harvest beluga whales are not impaired by OCS actions. If additional recoverable oil and gas resources are discovered and produced from existing leases in the Beaufort Sea, subsistence hunting activities would be subject to further analysis.

Gray Whale. Gray whales in the Beaufort Sea have not been harvested by Alaskan Natives for subsistence purposes in over a decade and are not expected to be so in the future; therefore a negligible level of effect is anticipated.

4.4.1.8.3.2.6. Anticipated Level of Effect from Habitat Loss.

This section refers to direct habitat losses as compared to changes in habitats arising from climate change. The anticipated level of effect from climate change is described in Section 4.4.1.8.3.2.9. Sources of habitat loss include community and industrial development.

Drilling on OCS leases is anticipated to occur as leaseholders explore potential productive oil and gas finds. Exploration drilling would likely involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible if development and production is pursued. If exploration drilling indicates development and production is feasible, drilling would be expected to continue at a rate determined by the number of drill rigs available.

4.4.1.8.3.2.6.1. Community Development. Some coastal and near shore habitat loss may occur from the expansion of human activities in nearshore and coastal areas.

Ringed, Spotted, Ribbon, Bearded Seals, and Pacific Walrus. Spotted seals are known to periodically use islands as haulout spots. Bearded seals also have been known to occasionally haulout on beaches. Some coastal and nearshore habitat loss may occur from community expansion in nearshore and coastal areas. Community development projects will continue to occur on an opportunistic basis as funding allows. If these projects occur on the coast, some displacement at haulouts can be expected. Haulouts along the Beaufort coast will be affected by coastal activities, making them less favorable to some marine mammals, forcing them to seek out alternative sites. These activities are anticipated to result in a negligible level of effect on ice seals or walrus in the Beaufort Sea.

4.4.1.8.3.2.6.2. Industrial Development. Some continued “infilling” of existing industry infrastructure is anticipated to continue, but these areas are concentrated in areas away from the shoreline used by some marine mammals. Some exploration drilling may occur on state leases, and this level of effect is anticipated to be similar to those associated with exploration drilling on OCS leases.

Drilling Wastes. Some drilling wastes could be discharged near the drilling site. However, the effects likely would be negligible, considering the discharge areas are small in relation to the available habitat. Drilling muds from development and production activities would be recycled and waste muds be disposed of offsite in disposal wells and not released into the marine environment.

Industrial Facilities. It is largely speculative at this time as to whether development and production would occur on existing leases, and there is a low potential that development and production of economically recoverable resource discoveries could occur. Development and production plans would be subject to MMPA compliance, as appropriate. Development and production would entail a suite of ancillary activities; product storage and transportation; infrastructure construction and maintenance; platform construction and maintenance; drilling; product gathering, production and processing; support vessel and aircraft for personnel, supply, and maintenance that would continue over the duration of production. Offshore developments currently planned in the Beaufort Sea include Liberty and Nikaitchuq. The Liberty development is expected to be an extended reach drilling project linked to facilities onshore and to Endicott. Reasonably foreseeable future developments in the Beaufort Sea include Sivuliq, Thetis Island, Sandpiper and others (see Table 3.1.1-1).

Ringed, Spotted, Ribbon, and Bearded Seals. Higher concentrations of ringed seals have been noted to occur near offshore oil and gas facilities (Moulton et al., 2003; Frost and Lowry 1988; Lowry and Frost 1988) in the Beaufort Sea. Noise producing developments near the fast ice habitat could cause ringed seals to abandon their lairs and breathing holes in greater numbers (Reeves 1998). Adult ice seals seem to habituate to industrial activity over time; however, we cannot determine what effects industrial developments may have on juvenile or neonate ringed seals. Bearded seals and spotted seals should not be impacted to a greater degree than are adult ringed seals. Consequently we anticipate a negligible level of effect to ice seals as a result of ongoing industrial developments in the Proposed Action area, with no additional effects under Alternative 1.

Pacific Walrus. Oil and gas exploration or development in nearshore waters under State jurisdiction could add incrementally to future loss of habitat in the Beaufort Sea region. If development and production occurs, facilities will be constructed to extract and transport product to existing processing facilities. None of these planned production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas currently used regularly by walrus for terrestrial haul outs or in optimum foraging habitats. There would not be any

permanent loss of walrus habitat during exploration and delineation activities. Some displacement of individual walrus may occur. The level of this impact would be negligible in the Beaufort Sea.

Beluga Whales. Potential production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure) are located in areas currently used regularly by beluga for important life functions (migration, calving, seasonal foraging concentration, nursing etc.). Exploration and development in State waters and OCS would add incrementally to beluga habitat loss in the Beaufort Sea region, but would be a negligible level of effect.

Gray Whales. Bottom-founded drilling units or gravel islands may inundate small areas of benthic habitat and seafloor that support benthic invertebrates upon which gray and other baleen whales feed. Such effects would be negligible in relation to the available habitat in the Beaufort Sea

The MMS will continue to apply required mitigation measures and conditions on OCS oil and gas activities on existing leases to avoid or minimize effects to whales. Mitigation measures that ensure negligible effects to marine mammals would be imposed by MMS, FWS, and NMFS via LOAs and IHAs issued under the MMPA.

Development and production resulting from existing leases are speculative at this time. Should development be proposed, production could entail constructing facilities for product storage and transportation, infrastructure construction and maintenance, platform construction and maintenance, drilling, product gathering/production/processing that would continue over the duration of production.

Turbidity or sediment suspension in marine waters as a result of gravel island construction, placement of fill, installation of gravel bags or sheetpile are not anticipated to affect gray whales. Such construction activities likely would occur in periods during winter when gray whales are not present, but ice seals are most common. Anticipated effects on gray whales and their prey would remain localized and affect a low number of individual gray whales and a very small proportion of the habitat and prey available. Effects would be negligible.

4.4.1.8.3.2.7. Anticipated Level of Effect from Environmental Contaminants.

Ringed, Spotted, Ribbon, and Bearded Seals. Ice seals accumulate heavy metals, organochlorine, and other toxins over the course of their lives, normally through consumption of food items. The literature suggests environmental contamination levels in northern ice seals are consistent with trends seen elsewhere with each respective species. Long-term monitoring could better assess temporal trends for the accumulation and effects of environmental contaminants in ice seals. Ongoing production and exploration in the Beaufort Sea has not increased the levels of contaminants in ice seals beyond that which would be expected elsewhere in the Arctic. A negligible level of effect is expected to continue as a result of ongoing oil and gas exploration and production in the lease-sale area. Moreover no additional contaminants are anticipated to result under Alternative 1.

Pacific Walrus. There is not enough current information on contaminant levels in walrus to be able to assess trends. Past studies have shown low levels of organochlorine, and heavy metals in walrus. Walrus are susceptible to bioaccumulation through ingestion of benthic prey items. Ongoing assessments of contaminant levels on a more regular basis would help to determine whether changes were taking place.

Beluga and Gray Whales. Contaminants could be released onto the sea floor during the drilling of exploration wells. Exploration drilling on past and existing leases would add incrementally to discharges into the Beaufort Sea. Local sites where releases may occur are dependent upon the number and location

of exploration wells. Mitigation measures require that most discharges (cuttings and drilling mud) from production wells be re-injected into an authorized disposal well. Discharges to the marine environment from exploration on existing leases could occur. Due to prey selection, beluga whales accumulate contaminants to a higher degree than baleen whales such as gray whales. Concentrations of PCBs, DDT and other pesticides have declined in the Arctic since the 1980s; however, cetaceans in the Arctic may still be at risk for adverse health effects (Wilson et al, 2005). Temporal trends in the levels of organic pollutants are not obvious. Studies comparing levels of POPs in the 1980s with levels in the 1990s show no apparent change (CDFO, 2000).

Summary. Exploratory drilling may result in the discharge of cuttings onto the sea floor. The effects from such discharges are expected to be localized to a small proportion of available marine mammal habitat. A negligible level of direct effect is anticipated from environmental contaminants from drill cuttings on marine mammals in the Beaufort Sea.

4.4.1.8.3.2.8. Anticipated Level of Effect from Petroleum Spills. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings. Particular concern has been expressed over increases in shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill-prepared to traverse these remote and dangerous areas.

Vessel-related spills on the high seas are considered infrequent. Concern has been expressed about increasing tourism and shipping vessel traffic between the Bering Sea and the North Atlantic, especially vessels with crews unaccustomed or ill-prepared for these remote and dangerous areas. If recent performance in the Antarctic is any indication, vessels transiting the Beaufort Sea during ice periods are prone to ice-related accidents. The ADEC (2007) reports the highest probability of spills of noncrude products occurs during fuel-transfer operations at remote North Slope villages.

Other sources of petroleum spills include a well blowout or other contamination from oil and gas exploration or development on State lease lands in the Beaufort Sea or on lease lands in the Canadian Beaufort. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4 and is unlikely to have adverse effects on pinnipeds or whales.

Ringed, Spotted, Ribbon, and Bearded Seals. Ribbon and spotted seals would be less likely to experience any adverse impacts from an oil spill as compared to bearded and ringed seals. Ribbon seals occur rarely in the Beaufort Sea, and spotted seals are normally found aggregated in a few key areas in the Beaufort and in small numbers. Bearded seals and ringed seals occur offshore, however bearded seals typically occur in lower densities than ringed seals. Immersion studies by Geraci and Smith (1976) resulted in 100% mortality in captive ringed seals. Unlike the animals in the immersion study, seals in the open water would have ice as a resting/escape platform as well as water depth and distance for escape routes from an oil spill. Most oil spills are relatively small, amounting to <1,000 gal of crude oil. While significant, such a spill is much less than the more notorious oil spills in history. In the event of an oil spill, OSRPs are in place that will initiate oil spill cleanup activities. For these reasons oil spills are anticipated to continue having a negligible level of impact on ice seals in the sale area.

Pacific Walrus. The potential effects of spills on walrus were described in Section 4.4.1.8.1.6. This alternative is anticipated to result in negligible impacts to walrus because petroleum spills are considered infrequent illegal or accidental events, and relatively few walrus inhabit the Beaufort Sea.

Beluga Whale. Potential effects from oil spills on beluga whales are discussed in Section 4.4.1.8.1.6. No large spills are anticipated to occur during exploration activities in the Alaska Beaufort Sea relative to existing leases. This alternative is anticipated to result in negligible impacts to beluga whales because

petroleum spills are considered infrequent illegal or accidental events. Fresh oil spills with high concentrations of volatile aromatic hydrocarbons into marine waters associated with the Beaufort and Chukchi spring lead system concurrent with large numbers of beluga whales migrating through the lead system, present the greatest potential for effects to large numbers belugas and vulnerable newborn calves.

There is uncertainty about effects on belugas in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding and molting beluga whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed; and we cannot rule out population-level effects, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that beluga whales would be likely to suffer significant population-level adverse affects from a large spill originating in the Beaufort Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move toothed whales away from oiled areas) could cause short-term changes in local distribution and abundance. A moderate level of effect could occur.

Gray Whale. No large spills are anticipated to occur during exploration activities in the Alaska Beaufort Sea relative to existing leases. The OSRA modeling runs predict the probability of such a spill scenario to be very low. The most likely number of spills $\geq 1,000$ bbl is zero (USDOJ, MMS, 2003a). The MMS requires companies to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment. Development/production projects and associated infrastructure for product transport may occur on existing leases in the Beaufort Sea OCS in addition to the Northstar and ongoing Liberty projects or adjacent State of Alaska oil and gas leases. It is anticipated that in the unlikely event of a large oil spill, some individual gray whales may experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number affected likely would be small. Some individual whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum and/or petroleum-contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Spilled oil, if chemical dispersants are used to break up surface oil and cause it to sink to the bottom, could negatively affect gray whales by contaminating benthic prey, particularly in primary feeding areas (Wursig, 1990; Moore and Clarke, 2002). Bottom muds could be contaminated and oil deposited on the bottom could be ingested by feeding gray whales. Any perturbation, such as an oil spill, which caused extensive mortality within a high-latitude amphipod population with low fecundity and long generation times would result in a marked decrease in secondary production (Highsmith and Coyle, 1992). Effects of exposure of whales to spilled oil may but are not anticipated to result in lethal effects to a few individuals, and most individuals exposed to spilled oil likely would experience a minor level of effect.

Small, chronic petroleum (fuel and oil) spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual whales potentially could be exposed to small fuel oil spills, and this exposure could have negligible effects on health.

4.4.1.8.3.2.9. Anticipated Level of Effect from Changes in the Physical Environment.

Trends in arctic warming are anticipated to continue.

Ringed, Spotted, Ribbon, and Bearded Seals. Alternative 1 is anticipated to result in a continuation of ongoing effects to ice seal populations. Under this alternative, the climate in the Alaskan Arctic will continue to change, sea ice will continue melting at an accelerated rate, the habitat quality of

the sea-ice will continue to change, and ecological processes could shift. Consequently, these changes will impact the ice seal populations in the Beaufort Sea to varying degrees that likely overshadow other existing and reasonable foreseeable impacts.

The loss of sea-ice is considered to be the primary threat to the long-term health and persistence of ice seals in the Beaufort Sea. Section 3.2.4.3 covers the long-term effects of sea-ice loss in greater detail. Ice seal species that prefer the fringe of the ice-pack (bearded, ribbon, and spotted seals) may alter their distribution to reflect the annual availability of the sea-ice edge with population shifts to the north. Ringed seals could respond to climate changes in a somewhat similar manner, by relying more on the pack-ice rather than the shorefast ice as has happened elsewhere (Finley et al., 1983) and possibly a seasonal shift to the ice, etc. Increased sea-ice retreat may eventually exclude ringed seals from shorefast-ice denning habitat in the analysis areas. Changes in ice thickness, quality, and quantity may have adverse effects on the survival of ice seal pups.

Other than the immediate loss of ice habitat needed for reproduction, the expected changes in the food web, and foraging areas could further challenge the ability of ice seals to cope with the anticipated environmental changes. Ringed seals are mostly restricted to sea-ice areas over the continental shelf with shallower water depths. On the other hand, ribbon seals mostly rely on the open ocean to forage for months on end. Bearded seals forage mostly on the benthos, however they can dive down to greater depths than can ringed seals. Lastly, spotted seals prefer to forage near the edge of the ice, but they too are limited by their diving capabilities for water depths that they can use. If the sea-ice recession continues as projected, the ice may one day lie over deeper waters which may be much less useable by ice seals.

If the climate predictions expressed in AICA (2004) prove true, ringed seal numbers may decrease as could their range as a species. Harwood and Stirling (2000) suggested that ringed seals could remain near-shore in open water during summer ice recession. However there is a possibility that ringed seals could eventually become extirpated from the Alaskan Beaufort Sea. Another possibility is that ringed seals may adapt to sea ice losses and use terrestrial haulouts, pupping in the sea (Fedoseev 1971, 1975; Lydersen and Smith 1989). Most of the literature agrees that a shift towards terrestrial haulouts is unlikely and that the losses of the sea ice could have severe consequences on ringed seal populations in the Proposed Action area.

Bearded seal numbers may decrease as could their range as a species. Bearded seal populations will likely follow the edge of the receding sea-ice seasonally as it retreats northward. Likewise spotted seal distributions should follow the fluxes in the extent of the pack-ice. Spotted seals use land-based haulouts from time to time, and so they may have the ability to adapt to climate change in the Chukchi and Beaufort seas analysis areas, especially because the food web is expected to shift to favor fishes, the preferred food source for spotted seals. Because ribbon seals spend most of their lives in the open ocean, they are not entirely dependent up on sea-ice for most of the year. However they are known to use pack-ice fringes as birthing and resting areas, and will need the sea-ice resources during key times of the year. Additionally the food web is expected to shift towards production of fish production, the preferred food source for ribbon seals. Consequently ribbon seals may adapt, or partially adapt, to environmental changes to a higher degree than ringed, bearded, or spotted seals.

It remains unclear whether ice seals will be lost or would shift their population to adapt to changes in food and other resource availability. If the food web shifts to favor the production of fishes over benthos, the diet of ice-dependent seal species may adjust to reflect the change.

Pacific Walrus. Specific future effects on walrus from climate change are difficult to predict with any certainty, however we expect current trends to continue and to accelerate over time (IPCC, 2007).

Habitat loss due to changes in climactic conditions, particularly changes in sea ice extent and duration, are expected to have major effects to walrus throughout their range. Walrus may spend more time onshore fasting or spend more time fasting on sea ice that has retreated over deep water that is not suitable for foraging. There may be declines in abundance and availability of benthic invertebrates as prey items. Declines in walrus fitness (as measured by weight, fat reserves and fecundity) may also occur. We anticipate that these ongoing trends may result in major impacts on walrus.

Beluga Whale. Direct and indirect effects from Arctic warming to beluga whales are not fully understood. Continuing monitoring and evaluation should allow activities to be adjusted as appropriate to protect beluga whales and their habitat.

Gray Whale. Direct and indirect effects from Arctic warming to gray whales are not fully understood. Gray whales appear to be expanding farther north into arctic waters, which is interpreted as a positive effect on gray whales. Continuing monitoring and evaluation should allow activities to be adjusted as appropriate to protect gray whales and their habitat.

4.4.1.9. Terrestrial Mammals.

Summary. Terrestrial mammals found along the Beaufort Sea coastal areas includes the caribou, muskox, grizzly bear, wolf, wolverine, arctic foxes, and red foxes. Caribou, muskoxen, grizzly bears, and the furbearers analyzed in this document are very important subsistence resources for local residents in the proposed action area.

The principal sources of potential adverse effects to terrestrial mammals in the Beaufort Sea includes:

- vessel presence and noise;
- aircraft presence and noise;
- vehicular traffic;
- subsistence;
- petroleum spills;
- habitat loss and degradation;
- seismic airgun noise;
- gravel mining; and
- changes in the physical environment.

These “impact-producing factors” are associated with community development; transportation; tourism; oil and gas exploration and development on private, State, and Federal lands; and climate change. Oil- and gas-exploration activities include vessel presence and noise, aircraft presence and noise, vehicular traffic, and seismic activity. Several established oil and gas developments exist in the Beaufort Sea proposed area such as the Endicott, Northstar and Oooguruk wells. Further production of oil or gas from existing leases in the Beaufort Sea is speculative. Seismic-survey activities in the Beaufort Sea continue under existing leases.

The marine and terrestrial systems in the northwestern Arctic are closely linked by seasonal and spatial interactions. While much of the area is perceived to be pristine, a number of past and existing sources of harm exist, along with an increasing number of threats to the terrestrial components of the ecosystem. Furthermore there are several projected environmental changes that will affect terrestrial mammals in the project area for centuries into the future, regardless of whether or not the proposed lease sales are held. While minimizing some of these effects could maintain the present condition of most mammal populations, some environmental influences are outside human control. Accordingly, some terrestrial mammal populations should become scarcer or extirpated within the next 40 years. Given the anticipated

adverse effects from reasonably foreseeable and speculative future events (Section 4.2), Alternative 1 (No Lease Sale) still would result in a moderate cumulative effect on most terrestrial mammals in the Proposed Action area. Furbearer species often move out onto the sea ice during the winter months to scavenge polar bear kills or to hunt seal pups. Consequently, terrestrial mammal species showing a significant amount of sea-ice use likely would experience very light to moderate impacts in the foreseeable future. Climate-induced changes to the terrestrial vegetative community most likely would affect the seasonal foraging and movement patterns of ungulates in the northwestern Arctic, most notably caribou and muskox.

If Lease Sale 209 or 217 were not conducted, the cumulative effect under Alternative 1 would consist of combining the existing status of terrestrial mammal resources with those impacts anticipated under the reasonably foreseeable and speculative future events. An overview of the consequences includes:

- The most important impacts to terrestrial mammals likely would arise from continued climate change and the loss of nearshore winter sea ice habitat changes that may affect migrations, foraging, and/or reproduction in ungulates and their predators. A warming climate may tip the interspecific competitive advantage in favor of red foxes instead of arctic foxes, and grizzly bears instead of polar bears. Caribou seem to have little difficulty adapting to willow-dominated rangelands; however, muskoxen generally prefer graminoid/shrub-dominated landscapes. While caribou easily cope with deeper snowpacks by cratering, muskox do not cope as well and may experience higher incidents of winterkill because of greater restrictions on accessible wintering ranges.
- Climate-induced changes to the benthos in the marine environment conceivably could lead to conditions favoring large populations of salmonids. Larger returns of salmon into the streams could provide the riparian systems with a seasonal surge in nutrients that could lead to increased terrestrial productivity with the capability of supporting larger numbers of herbivores and subsequently carnivores.
- Seismic surveys and other post lease exploration activities for existing OCS leases in the Beaufort Sea require specific mitigation or avoidance measures that reduce future impacts to terrestrial mammals to no more than a negligible level.
- Climate-related changes will continue to occur to terrestrial mammal habitat along the Beaufort Sea, perhaps to a greater extent than all other anticipated effects combined.

More attention to minimizing these effects could reduce anthropogenic sources of stress or mortality to terrestrial mammals near the Beaufort Sea. Some of these mammalian populations are subject to influences or harm well outside the proposed action area, such as calving areas, migration corridors, and wintering areas that have contaminated or altered habitats or an increased human harvest or predation. The long-term effects of these changes are difficult to analyze, much less predict. We anticipate that existing trends will continue, and selection of Alternative 1 would result in negligible effects on terrestrial mammals.

4.4.1.9.1. Potential Effects to Terrestrial Mammals.

4.4.1.9.1.1. Potential Effects from Vessel Presence and Noise. Vessel traffic is expected to increase in the Proposed Action areas in the Beaufort and Seas as a result of a longer ice-free period in the Arctic shipping lanes. This increase in traffic is not expected to result in any significant impacts to caribou, muskoxen, or grizzly bears. While there is evidence of furbearers using areas of sea ice for hunting and scavenging during the winter, no detailed studies have been performed along the Beaufort Sea to determine foraging distances, success rates, or importance of the sea ice to terrestrial furbearers. Based on the level of existing knowledge, vessel activity and noise in the Beaufort Sea analysis area is expected to have negligible impacts on terrestrial mammals.

4.4.1.9.1.2. Potential Effects from Aircraft Presence and Noise. Aircraft flying under 1,000 ft have been known to frighten caribou and muskoxen, forcing herds and individuals to scatter, separating cows from calves, and possibly causing individuals to injure themselves during the panic. While grizzly bears do not aggregate in the sense that ungulates do, they too have been known to panic when approached by low-flying aircraft. In these instances the tendency is for a grizzly to seek out the nearest cover such as willows, so that they may hide until the perceived threat passes. In a situation such as this, it is conceivable that a female grizzly could become separated from her cubs. As with caribou and muskoxen, such a separation from their parent would most likely result in the death of the offspring.

There is a gap in our understanding pertaining to the effects of aircraft on furbearers; however, for the most part we must assume that wolves and wolverines exhibit much the same behavior as do grizzly bears. Arctic and red foxes are known to readily habituate to aircraft presence, noise, and associated activity.

4.4.1.9.1.3. Potential Effects from Vehicular Traffic. Caribou, muskoxen, grizzly bears, and most furbearers are keenly sensitive to the use of vehicles in their surroundings. As with aircraft, vehicles have the tendency to frighten most terrestrial mammals into a panic (Stokowski and LaPoint, 2000). Once panicked, some individuals may injure themselves trying to escape, or become separated from offspring or a herd. Consequently, an individual animal may or may not show signs of the sublethal effects of vehicular disturbance that often results in an overall decrease in individual animal's fitness.

A secondary effect of vehicular traffic is the ability to hunt over a much larger area than would otherwise be feasible. The increased efficiency in hunting could lead to the overharvest or unauthorized killing of some game species (Lee, 2008; Halpin, 2008; McLellan, 1990) in areas that otherwise would experience less hunting pressure or success.

Oil- and gas-related vehicular traffic is strictly regulated by industry operators in developed locations near or adjacent to the Proposed Action areas, and is normally transient and of short duration. Vehicle use by the local citizenry living along the Beaufort Seas is unregulated. Regulated vehicular activity in the Proposed Action areas creates temporary disturbances along existing transportation corridors. The effects of unregulated private vehicle use creates disturbances greatly exceeds those of regulated vehicle use in the area impacted, the duration of impacts, and the magnitude of the impacts.

4.4.1.9.1.4. Potential Effects from Subsistence. The relationship between subsistence and terrestrial mammal populations is covered in Section 3.4.2. The impacts from subsistence have not resulted in any documented population-level effects on terrestrial mammals in the Proposed Action area.

4.4.1.9.1.5. Potential Effects from Petroleum Spills. In the event of an oil spill, a few terrestrial mammals may be exposed to oil along the coastline. If such an event were to occur, an animal's fur could become oiled, losing its insulative value. A possible side effect of such an oiling might be a decrease in an individual animal's overall health or ability to thermoregulate. Other potential effects could occur through prolonged inhalation of the fumes from an oil slick, leading to the development of lesions on the lining of the lungs or eye irritation; or through ingestion of contaminated food items which could lead to kidney or liver damage.

While caribou and muskoxen might accidentally consume oil by grazing on oiled plants, grizzlies and furbearers may ingest it by scavenging on an oiled carcass or by predating oiled prey animals. The potential effects to terrestrial mammals from ingesting crude oil could be lethal, based on studies where cattle were exposed to oil (Kahn, Line, and Aiello, 2005); however no conclusive studies have been conducted in the proposed action area to shed light on this possibility.

4.4.1.9.1.6. Potential Effects from Habitat Loss and Degradation. The most important impacts to terrestrial mammals likely would arise from climate change induced changes in vegetation and the loss of nearshore winter sea ice. Habitat changes that may affect foraging, migrations, and reproduction strategies in ungulates and predators. A warming climate may tip the interspecific competitive advantage in favor of red foxes instead of arctic foxes, and grizzly bears instead of polar bears. Caribou may have difficulty adapting to shrub or tree-dominated rangelands; muskoxen generally prefer graminoid/shrub-dominated landscapes. While caribou easily cope with deeper snowpacks by cratering, muskox do not cope as well and may experience higher incidents of winter kill because of decreases in accessible wintering ranges.

Climate-induced changes to the benthos in the marine environment conceivably could lead to conditions favoring large populations of anadromous fishes (ACIA, 2004). Larger returns of anadromous fishes into the streams could provide the riparian systems with a seasonal surge in nutrients that could lead to increased terrestrial productivity over the course of several decades. The result might be an improved capability of supporting larger numbers of terrestrial fauna. Gunn (1995) stated that the most likely warming climates will result in decreased caribou and muskox populations because of an increase in the magnitude and frequency of severe weather events.

Another development that may occur as a result of warming temperatures would be the melting of the permafrost and the ensuing release of sequestered carbon and nitrogen into the local ecological communities. In such a situation, and with longer growing seasons, the vegetative community may respond with increased production or a shift that could support vegetation from a more southerly climate. Another effect from thawing permafrost may be soil subsidence that would allow sea water to flood into areas of the Arctic Coastal Plain, potentially destroying large blocks of crucial habitat.

Regardless, climate-related changes will continue to occur to terrestrial mammal habitat along the Beaufort Sea, perhaps to a lesser or greater extent and any scenarios that are put forth in this section are only speculative possibilities and based on expectations derived from existing models.

4.4.1.9.1.7. Potential Effects from Seismic Noise. Seismic activity has not been shown to present any identifiable impacts to terrestrial mammals other than when conducted onshore, or perhaps during the winter in offshore or nearshore areas. In these instances, the activity by people would be the main contribution factor rather than the noise produced by the actual seismic-surveying equipment. Consequently, any impacts from ongoing seismic surveys would be transient and of negligible immediate effect on terrestrial mammals.

4.4.1.9.1.8. Potential Effects from Gravel Mining. Gravel is mined locally from deposits in the foothills of the Brooks Range and used as construction material for manmade islands, foundations, etc. Harding (1976) found that 78% of the grizzly bear den sites in his study in the Canadian Northwest Territory were situated in steep stream or lake banks, and 13% were located in slumped lake or channel banks. Most of the dens were located under clumps of alder or willow.

McLoughlin, Cluff, and Messier (2002) found that barren ground grizzlies in the Central Arctic excavated dens under dwarf birch more than any other plant species. Their conclusions agree with those of previous studies (Harding, 1976) in that the preferred substrate for grizzly dens is sandy soils that sometimes had a clay/silt/cobble content with a slope of about 25%. They went on to suggest that gravel could be too loose for structurally sound dens.

Gravel mining has the potential to disrupt den construction if performed during the May thru October period (McLoughlin, Cluff, and Messier, 2002). If mining activities occur during the October thru April

timeframe, the chance exists that grizzlies may be awakened from their sleep and driven away or unintentionally killed by the act of mining with heavy equipment.

4.4.1.9.1.9. Cumulative Effects from Global Forces. The potential effects derived from changes in the physical environment were described in Section 4.4.1.9.1.6 and will not be covered here.

4.4.1.9.2. Mitigation Measures. The following mitigation measures are in effect to protect terrestrial mammals during Federal and State seismic activities and exploration drilling operations in the Chukchi Sea and Beaufort Sea.

- Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic-substance spill. The FWS requires that wildlife hazing equipment (including Breco buoys or similar equipment) be pre-staged and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site oil-spill-response vessel, to ensure rapid deployment in the event of a spill. This requirement should suffice in cleaning up any oil spills before terrestrial mammals can encounter a spill.
- Aircraft supporting drilling operations will avoid operating below 1,500 feet above sea level to the maximum extent practicable (ADNR, 1999). If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Predesignated flight routes will be established by the lessee and MMS, in collaboration with the ADF&G, during review of the EP. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.
- In accordance with the State of ADNR 1999 Final Finding of the Director, no exploration or production activities may be conducted within ½ mile of occupied grizzly bear dens without alternative mitigation measures approved by ADF&G. Occupied den sites must be reported to ADF&G as they are discovered and avoided by a ½-mile buffer.
- Develop and implement bear action plans as described in the ADNR 1999 Final Finding of the Director.

4.4.1.9.3. Anticipated Effects Under Alternative 1.

Terms Used to Define a Level of Effect. The terms negligible, minor, moderate, and major are used to describe the relative degree or anticipated level of effect of an action on terrestrial mammals. Following each term given below are the general characteristics we used to determine the anticipated level of effect. For all terms, best professional judgment was used to estimate population size when current or precise numbers were not known.

Negligible: Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across 1 year. No mortality is anticipated. Mitigation measures are implemented fully and effectively or are not necessary.

Minor: Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year. Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local postbreeding population. Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate: Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year, but less than a decade. Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local postbreeding population, which may produce a

short-term population-level effect. Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major: Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer. Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local postbreeding population, which could produce a long-term population-level effect. Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are widespread and long-lasting.

4.4.1.9.3.1. Direct and Indirect Effects Under Alternative 1. Oil spills may result in the ingestion, inhalation, or exposure of terrestrial mammals to crude oil. What information we do have suggests that physiological stress or damage may occur as an effect of contacting or ingesting crude oil. Ingesting contaminated food items has been linked to liver damage, kidney damage, and respiratory damage in some cases.

Alternative 1, the no-action alternative, will not reduce the ongoing levels of oil and gas exploration and activity in the Proposed Action area. Terrestrial mammal species in the area will continue to be impacted by climate change, increasing vessel and aircraft traffic, subsistence, ongoing seismic surveys, etc. Consequently, the temporary displacement of a small number of caribou, muskoxen, grizzly bears, and furbearers from preferred habitats could occur.

Chronic disturbances can have moderate effects over time; however, existing mitigation is expected to moderate potential impacts to terrestrial mammals. Disturbances that do occur are expected to be transient, producing negligible levels of impacts on the fitness and survival of most terrestrial mammal species. Offshore seismic activity should have no effect on terrestrial mammals while the levels effect from onshore seismic activity would be negligible. Vibroseis activities are temporary and may displace the occasional terrestrial scavenger or hunter on the sea ice. Both vibroseis and seismic surveys should have no impacts on grizzly bears, caribou, or muskoxen in the Proposed Action area.

Vessel traffic in the Beaufort Sea is assumed to present a negligible level of impact during the ice-free season. Activity from icebreakers may pose a moderate level of impact to furbearers foraging on the sea ice by cutting off their movement routes onto and from the sea ice. Vehicular traffic associated with offshore oil and gas exploration may include snowmachines, rollagons, snowcats, ATVs, and automobiles in some areas. Considering the stringent regulations governing vehicle use by the oil and gas industry, only transient disturbances with negligible effect levels are expected under Alternative 1. At this time, it is likely that unregulated vehicle use poses a moderate threat to some terrestrial mammal species in the Proposed Action area.

Aircraft traffic has been identified as a strong source of disturbance to caribou, muskoxen, grizzly bears, etc. Studies have indicated maintaining an altitude no less than 1,000 ft should greatly mitigate any adverse effects to terrestrial mammals that otherwise might occur. For this reason, industry-driven and -regulated aircraft operation in the Proposed Action area is expected to have a negligible level of effect on terrestrial mammal populations. Unregulated aircraft use by individuals is expected to have a moderate level of effect on terrestrial mammals.

4.4.1.9.3.2. Cumulative Effects Under Alternative 1. Terrestrial mammals would continue to be exposed to a variety of potential negative effects, including disturbances, habitat loss, and shifts in predator populations, during the reasonably foreseeable future. The greatest source of adverse effects for terrestrial mammal species in the Proposed Action area is most likely to be climate change. Other smaller scale sources of disturbance include vehicular and aircraft traffic, and subsistence and sport hunting.

Important areas include calving grounds, riparian habitat, denning habitat, migration routes, and barrier islands, where some ungulates become stranded after breakup. Barrier islands and coastlines also provide important habitat away from the swarms of biting insects that plague the wetter areas in the western Arctic. While existing oil and gas exploration activities in the Beaufort Sea area may increase numbers of some activities (e.g., vessel or aircraft trips) that could impact terrestrial mammals, the incremental effects of those additional impacts to terrestrial mammals around the Beaufort Sea should be negligible.

Climate change will exacerbate the ongoing erosion of arctic coastlines and barrier islands through increased storm waves/tidal surges, increased snow deposition, and larger storm events (Gunn, 1995). If winter snowpacks deepen, the winter range for caribou and muskoxen may decrease, because they are adapted for wind-scoured areas or areas with shallow snow depths where they can graze. Warming trends may result in unforeseen changes in vegetation cover and growing seasons. These vegetative changes could elicit adaptive behavioral changes in terrestrial mammals to allow them to respond to the changed environment. Gunn and Skogland (1997) support the opinion that changes in seasonality, weather, and vegetation could affect caribou populations. However, to what degree caribou will be affected remains unclear at present.

Climate change is expected to have major effects on grizzly bears in the northwestern Arctic, because the marine food web is expected to shift from benthic consumption and production to pelagic consumption and production. In this scenario, larger salmon runs could result in a greater affinity between grizzlies and salmon spawning streams. Moreover, because >80% of the grizzly diet is composed of vegetative matter, a warming climate might result in increased primary production, providing sufficient precipitation occurs coincidentally to allow for increased plant growth. Speculatively, such a situation could provide a larger food base for many species in the Proposed Action areas.

During winter, wolves, wolverines, and red and arctic foxes often hunt or scavenge on the sea ice. Climate change is expected to have major effects on furbearers in this project area. As warming increases and the ice recedes from the coasts for greater lengths of time, foraging time on the ice might decrease, and these species would move onshore for hunting and scavenging. Climate change could force furbearers to hunt and scavenge in onshore areas with greater frequency during winter. Furthermore, the range of red foxes has been expanding from the Brooks Range towards the arctic coasts, such that there is a complete overlap between arctic fox and red fox species ranges on the coastal plains. Conceivably, arctic fox populations may enter a decline in the Proposed Action area, as the warming trends continue and red fox population populations increase.

Increased ATV, snowmachine, and aircraft travel likely will continue to occur in the analysis areas. Vehicle use in existing oil- and gas-extraction areas is tightly controlled, unlike the use of vehicles by private citizens living along the Beaufort Sea.

Ultimately, terrestrial mammal populations along the Beaufort Sea may not respond to climate change in the same manner as marine mammals. Many of the species present also occur in latitudes farther south, so they probably are capable of adapting to a warming climate up to a point. In spite of Alternative 1 being the no-action alternative, ongoing changes in the climate, unrestricted ATV and snowmachine use by private citizens, and subsistence hunting in the Proposed Action areas are expected to have major levels of adverse effects on terrestrial mammal populations.

4.4.1.9.3.2.1 Anticipated Level of Effect from Vessel Presence and Noise. Vessel activity in the offshore zones is expected to increase in support of existing lease developments in and along the Beaufort Sea. This type of activity, while increasing, occurs in habitats that are only useable to grizzly bears and terrestrial furbearers during the months when landfast ice develops. Icebreakers may produce temporary lead systems, which then could isolate the occasional terrestrial predator hunting or scavenging on the ice. However, we conclude that there is a low likelihood of such a scenario occurring, and that it is very unlikely that such an event would result in the mortality of a terrestrial mammal. Existing vessel presence and noise is expected to result in a negligible level of effects on terrestrial mammals in the Proposed Action area.

4.4.1.9.3.2.2. Anticipated Level of Effect from Aircraft Presence and Noise. The number of aircraft operating in the Proposed Action area is anticipated to increase to support exploration and development activities on existing leases. Consequently the amount of aircraft-related disturbances to terrestrial mammals also is expected to increase. Existing aircraft presence and noise are expected to continue to have a negligible level of effects on terrestrial mammal species.

4.4.1.9.3.2.3. Anticipated Level of Effect from Vehicular Traffic. The use of off-road vehicles and development of new transportation corridors to support existing operations may have a negligible level of impact on terrestrial mammals in the Proposed Action area. However, in the larger context, the impacts associated with off-road vehicle use could develop into moderate levels of impact over the region as a whole, because ATV use allows hunters to access underexploited groups of animals with less effort, thereby disturbing them. Vehicular traffic is expected to result in moderate levels of effects on terrestrial mammal species.

4.4.1.9.3.2.4. Anticipated Level of Effect from Subsistence. The current levels of subsistence hunting in the region are expected to continue out into the future. Moderate levels of effects on terrestrial mammal populations are expected to continue.

4.4.1.9.3.2.5. Anticipated Level of Effect from Petroleum Spills. Relatively few oil spills have occurred in the Proposed Action area. Based on our current knowledge of the Proposed Action area, there have been no deaths to terrestrial mammals from oil spills under existing levels of oil and gas production. Continued negligible effects on terrestrial mammals from petroleum spills are anticipated.

4.4.1.9.3.2.6. Anticipated Level of Effect from Habitat Loss and Degradation. The Arctic Coastal Plain is very sparsely populated with indigenous communities located along the coasts. No new communities or major construction projects are being proposed or planned outside of the existing communities. Some development could occur as a result of the Liberty project and from the development of existing oil and gas leases in the area. However, the preponderance of the developments would occur in the offshore or nearshore areas, not in habitat that is usable for caribou or muskox. Grizzlies, wolves, and other furbearers could use some of the nearshore and offshore areas on a seasonal basis; however, studies suggest most terrestrial predators easily habituate to industrial activity so long as they are not harassed. The exception to this rule is the wolverine, which is not known to habituate very well to manmade developments. Wolverines occur in such all numbers that they should not be greatly affected by the development that has occurred and continues to occur in the planning area. Negligible effects from community and other industrial development in terrestrial mammal habitat are expected to occur.

4.4.1.9.3.2.7. Anticipated Level of Effect from Seismic Activities. Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is done during winter. Offshore surveys on submerged State and Federal lands are conducted by vessels during the open-water period.

The State of Alaska is considering leasing additional State-owned tide- and submerged lands lying between the Canadian border and Point Barrow. Oil and gas development in nearshore waters under State jurisdiction should not add appreciably to the current negligible levels of disturbance to terrestrial mammals from seismic activity along the Beaufort Sea coast. Seismic activity is anticipated to result in a negligible effect on terrestrial mammal species.

4.4.1.9.3.2.8. Anticipated Level of Effects from Gravel Mining. Gravel will continue to be mined locally from deposits in the foothills of the Brooks Range. McLoughlin, Cluff, and Messier (2002) suggested gravel alone could be too loose for structurally sound dens, without shrub root systems to reinforce denning sites.

Gravel mining has the potential to disrupt grizzly bear den construction if performed during May through October (McLoughlin, Cluff, and Messier 2002). If mining activities occur during the October through April timeframe, the chance exists that grizzlies may be awakened from their sleep and driven away or unintentionally killed by the act of mining with heavy equipment. Existing mitigation, as outlined by the state of Alaska (ADNR, 1999), should prevent any industry-related disturbances or mortalities to grizzly bears from occurring. Gravel mining is anticipated to result in negligible levels of effects on terrestrial mammal species.

4.4.1.9.3.2.9. Anticipated Level of Effect from Changes in the Physical Environment.

Section 3.2.3 describes the ongoing effects from changes in oceanographic processes and sea-ice distribution, duration of snow and ice cover, distribution of wetlands and lakes, and sea level rise. Sections 3.3.8 and 4.4.1.10 described existing and predicted vegetation changes in the Proposed Action area. These changes in the physical environment may affect terrestrial mammal populations throughout the Arctic.

Some of these expected changes could benefit terrestrial mammals using habitats along the Beaufort and Sea coasts. An increase in productivity from a longer growing season could increase the amount of forage plants available for consumption by herbivores such as caribou and muskox. Terrestrial carnivores may benefit from larger returns of salmon in certain areas, and new populations of salmon in others. If the number of salmon spawning streams increases, the landscape may eventually support more bears, and furbearers. In contrast, increased storm events and snow depths could create additional energetic demands on herbivores and predators in the region. In particular, a deeper snowpack might prevent caribou or muskoxen from reaching winter foods hidden beneath the snow.

Climatic change could have stochastic or habitat effects on many species that may surpass the impacts of other activities. As previously stated, however, the implications of climate change on threatened and endangered birds are impossible to predict with any precision. For purposes of analysis, we assume most of the obvious trends are anticipated to continue. Continued climate change is anticipated to result in major effects on terrestrial mammal species.

Under Alternative 1, ongoing exploration and development from previous and future Federal and State lease sales will continue unabated. Under this and all other scenarios the ongoing climatic changes in the physical environment will continue to occur in the Proposed Action area. These changes are detectable in snow depth, coincidence of precipitation, ice formation and quality (Section 3.2.4); in weather patterns and climate (Section 3.2.2); coastal erosion; hydrology (Section 3.2.5); air quality (Section 3.2.6); and changes in soil nutrient balance through losses of carbon and nitrogen sequestered in the frozen soils. Changes in the physical environment are expected to result in a major level of effects on terrestrial mammal species throughout northern Alaska, including the Proposed Action area.

4.4.1.10. Vegetation and Wetlands. Tundra vegetation and wetland loss occurs as facilities are developed, directly covering the area within the individual project footprint. Hundreds of acres on the North Slope have been filled by oil and gas infrastructure (fill pads, pipelines, roads, gravel, pits, etc.), as well as community development (residences, schools, airports, roads, landfills, etc.). Secondary impacts occur from altered hydrology associated with these facilities, flooding areas and drying others. Altering the hydrology of vegetation and wetlands for extended periods of time usually results in a shift in the vegetation complex and often introduces noxious weeds or vegetative communities with an overall lesser value than the naturally occurring system.

4.4.1.10.1. Potential Effects to Vegetation and Wetlands.

4.4.1.10.1.1. Potential Effects from Construction Activities.

Loss of Tundra Vegetation Acreage. Tundra vegetation cover is removed permanently in areas where gravel borrow pits are established and where pipelines are buried. Pipeline burial under tundra has been the exception on the North Slope rather than the norm, and it is expected that substantial lengths of buried pipeline would continue to be an unlikely event. Tundra vegetation also is buried under gravel pads established for the construction of pump stations and under gravel roads and runways. Communication lines and vertical supports also require the removal or burying of tundra vegetation. The burial of vegetation results in the death of the vegetation within the footprint of the given project.

Damages to Vegetation Cover. Vegetation cover experiences damage from roadside dust and compression caused by ice pads and ice roads.

Roadside dust produced by gravel roads is known to cause loss of vegetation, specifically of mosses typically found on acidic soils of the tundra. Sphagnum moss is particularly sensitive to the toxic effects of calcium in the dust; a reduction or elimination of sphagnum moss, especially in the 0- to 10-m range adjacent to the road, has been reported in acidic tundra habitat (Walker et al., 1987). Mosses promote low soil temperatures and permafrost development by conducting heat under cool, moist conditions and by insulating soils under warm dry conditions (Oechel and Van Cleve, 1986). The loss of vegetation near the road, to some extent, is responsible for the extensive thermokarst features developed along older roads. Another impact is the earlier meltdown of the snowdrift accumulated near roads, because the darker dust covering snow surfaces absorb heat. Earlier meltdown could provide early open areas to wildlife several days or weeks before adjacent snow-covered tundra becomes accessible.

Changes in Plant-Species Composition. Changes in vegetation have occurred as a result of roadside water impoundments, changes in hydrology, and thermokarst effects. Permanent gravel pad substrates also have had impacts on plant communities and often colonize with an entirely different vegetative complex than the surrounding substrate.

The tundra is made up of numerous and complex wetland systems. Gravel roads often traverse breached lakes, which are abundant on the North Slope. Drainage systems on the flat tundra are complex and often have several unconnected drainage paths. Runoff moves as sheet flow in many areas of the arctic tundra. This environment makes it difficult to predict meltwater drainages and culvert positions along roads. Even with the use of culverts, hydrology often is altered as a result of culverts remaining frozen well into the spring, thus impacting sheet flow. As a result, changes in hydrology have been known to cause shifts in plant-species composition.

Changes in plant-species composition also have occurred as a result of thermokarst (irregular depressions caused by melting and heaving of frozen ground). Thermokarst generally occurs where gravel roads and

gravel pads have caused changes in an adjacent areas' moisture regime, natural drainage patterns, or snow-drift patterns (NRC, 2003a).

Introduction of Noxious Weeds. Permanent gravel roads act as corridors for the migration and dispersal of non-native plants and noxious weeds into the Arctic. Construction equipment also has been known to introduce non-native plants and noxious weeds during various construction projects using borrow from gravel pits. Non-native plant species, however, may lack physiological and morphological adaptations required to survive extreme arctic conditions. Non-native plant growth and production has been limited largely by extreme low temperatures in the soil, short photoperiods, and sporadic midsummer freezes (NRC, 2003a).

Public Access to Isolated Vegetation Communities. A long-term indirect effect of roads is the access they provide to vast areas of undisturbed tundra vegetation. This increases the potential for impacts to otherwise isolated plant communities as a consequence of unstructured off-road traffic.

4.4.1.10.1.2. Potential Effects from Discharges and Oil Spills. Discharges include diesel, hydraulic fluids, and other fluids used in the operation of shore-based facilities and pump-station equipment. Vegetation recovery from diesel fuel spills is slow. In experimental spills of crude oil and diesel fuel, tundra plant communities on diesel fuel plots showed no recovery after 1 year, with almost no recovery of mosses, lichens, and dicots (no graminoids).

Small oil spills generally have originated from onshore operation activities such as shore-base facilities, pump stations, and onshore pipelines. Small spills along pipelines and from shore-based facilities generally have caused localized damage to tundra vegetation. The level of damage associated with any oil spill is relative to the location of the spill. Should a spill occur in the vicinity of a waterway or the tidal zone, the potential for greater impacts exists. Small oil spills that have occurred on snow-covered tundra usually have been constrained by the snow layer and have afforded prompt cleanup efforts to minimize impacts to vegetation. To date, there is little activity on the OCS and, therefore, oil spills originating from offshore activities have been minimal and presented a minimal threat to existing estuaries and saltmarshes. To date, large oil spills have not occurred on the Arctic OCS from OCS activities.

4.4.1.10.1.3. Cumulative Effects from Global Forces. Scientific evidence indicates that tundra habitats have changed and will continue to change. Perhaps the most important changes to vegetation in the Arctic are expected in the form of expanding and retreating lakes and wetlands. Much of the ACP is underlain with permafrost. Permafrost close to the surface plays a major role in freshwater systems, because it often maintains lakes and wetlands above an impermeable frost table, which limits the water-storage capabilities of the subsurface.

Permafrost is warming along with the rest of the Arctic. Scientific models predict that large-scale changes in permafrost are likely, and significant permafrost degradation has been reported in some locations.

As warming continues, some regions of the Arctic will see shifts in permafrost distribution and deepening of the active layer, accompanied by changes in vegetation. The active layer is the topmost layer of permafrost that thaws during the summer, allowing organic processes to occur. As the active layer becomes saturated, it is prone to collapse (mass wasting). Permafrost collapse tends to result in the slumping of the soil surface and flooding followed by a complete change in vegetation, soil structure, and many other important aspects of these ecosystems. Initially, over an unknown period of time, flooding results in a boost of vegetative productivity and the expansion of wetlands and shallow lakes. Over time,

however, as the permafrost continues to melt and infiltration increases, shallow summer groundwater tables continue to drop, and subsequent drying of wetlands and drainage of lakes occurs.

Recent studies using satellite and field data have revealed remarkable changes in the number and total area of Arctic lakes and wetlands in just the past few decades. A preliminary assessment is that they are growing in northern areas of continuous permafrost, but disappearing further south. Lakes in areas of continuous and discontinuous permafrost have experienced substantial shrinkage, likely due to permafrost degradation, allowing them to drain to the subsurface. A study of lakes in Siberia observed that many lakes have disappeared or shrunk in the last 30-40 years (Smith et al., 2005).

Sea Level Rise. Sea level rise is regarded as one of the more certain consequences of global climate change. During the past 100 years, sea level has risen at an average rate of about 1-2 mm per year (or 4-8 in per century: USGS, 2007; Titus and Narayanan, 1995). The projected two- to fivefold acceleration of global average sea level rise during the next 100 years will inundate low-lying coastal wetland habitats that cannot move inland or accrete sediment vertically at a rate that equals or exceeds sea level rise.

Coastal wetlands are particularly vulnerable to sea level rise associated with increasing global temperatures. Freshwater systems in the Arctic are dominated by a low energy environment and cold region processes. Changing rates and timing of river runoff will alter the temperature, salinity, and oxygen levels of coastal estuaries. Inundation by rising sea levels, intensification of storms and higher storm surges threaten coastal estuaries and wetlands. For many of these systems to persist, a continued input of suspended sediment from inflowing streams and rivers is required to allow for soil accretion.

4.4.1.10.2. Mitigation Measures. The following mitigation measures could be implemented on a site-specific basis when feasible to ensure that tundra vegetation and wetlands would be protected from direct impacts to the greatest extent practicable. The necessity for and effectiveness of the potential mitigation measures below would be dependent on the specific activities proposed and the particular location involved.

- Critical wetlands and sensitive areas would be identified, and construction of facilities would be avoided in such areas.
- Discharge of produced waters in open or ice-covered marine waters <10 m in depth is prohibited.
- Oil-spill-prevention and -control plans and contingency actions would be prepared to address prevention, detection, and cleanup of oil spills.
- Pipeline leak-detection systems would include the use of pigs (bullet-shaped devices that slide through pipelines to look for corrosion). Pig runs would be implemented systematically.
- Impacts would be minimized by restricting winter and summer off-road traffic, and road layout would be coordinated with standards.
- Gravel extraction would be conducted during winter. Transport and construction activities would be conducted using ice roads and ice pads.
- Overlaying material covering gravel borrow pits would be removed and set aside in overburden stockpiles. The organic-rich silt referred as “tundra sod” would be separated and stockpiled for later use in land rehabilitation.
- Gravel pits probably would be filled with water and shaped to provide appropriate depths along pond fringes to create the right conditions for emergent and aquatic vegetation growth (critical component in creating fish and waterfowl habitat).
- To prevent vegetation impacts related to thaw of the permafrost zone, gravel pads would be built more than 1.8-m thick and, if needed, polyethylene insulation would be placed below the pads to reduce the amount of gravel necessary.

- Techniques to rehabilitate thick gravel pads likely would include reusing tundra sod by spreading it on gravel pads to improve productivity, sustain long-term plant growth, and allow for the establishment of a broad range of plant species.
- The creation of berms to capture drifting snow, modification of gravel pads' hydrologic balance, and the addition of soils amendments would increase water retention and mulch to reduce evaporation (Jorgenson and Joyce, 1994).
- Gravel-pad restoration would include the use of nitrogen-fixing arctic native legumes (*Astragalus alpinus*, *Hedysarum alpinum*, *H. mackenzii*, *Oxytropis borealis*, *O. campestris*, etc) and other native species, as well as the use of sewage sludge.
- The removal of gravel pads and remediation of contaminated soils would be used when feasible.
- Bioremediation techniques would be used, if necessary, to accelerate vegetation recovery in areas affected by large spills.
- Mitigation measures for an offshore large spill would include the protection of sheltered saltmarshes and estuaries with booming and skimming operations, if climatic conditions permit (Owens et al., 1977).

4.4.1.10.3. Anticipated Level of Effects Under Alternative 1. This section describes the impact on vegetation and wetlands resulting from the incremental impact of the action (which for this alternative is taking no action) and adding it to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Past and present actions are described in Sections 3.1 and 4.4.1.1 as they affected vegetation and wetlands. Reasonably foreseeable future actions are described in Section 4.2.1. The mitigation measures (described in Section 4.4.1.5) and the following important factors are considered in determining the anticipated effects from this alternative.

4.4.1.10.3.1. Anticipated Level of Effects from Construction Activities. Existing human development in coastal areas of the Chukchi and Beaufort seas is relatively sparse and limited to several small communities that include Point Hope, Point Lay, Wainwright, Barrow, and Kaktovik (Section 3.4.3). The closest industrial development of size southwest of the proposed lease areas is the Red Dog Mine Port site near Kivalina. Existing industrial developments (Kuparuk and Prudhoe Bay fields) are east of Teshekpuk Lake (Section 3.1.2). Small amounts of development likely will occur in and around these sites in the future, and correspondingly small amount of tundra vegetation will be lost. Secondary effects from the zone of influence around new or expanded developments would also result in tundra vegetation and possibly palustrine wetland loss.

Oil and gas exploration or development in nearshore waters under State jurisdiction could add to tundra vegetation and palustrine wetland loss in the Beaufort Sea regions, should additional support infrastructure be constructed or spills occur.

There would not be any permanent loss of tundra vegetation or palustrine wetlands during exploration and delineation activities.

Future production of oil and gas resources on the Beaufort Sea OCS remains speculative, but if it were to occur, facilities would be constructed to extract and transport product to existing facilities. Direct impacts such as permanent tundra vegetation and palustrine wetland habitat loss could occur, if pipeline landfall to an existing onshore facility were constructed or new onshore facilities were needed to support the oil and gas activities.

A pipeline is expected to be placed on elevated structures or, less frequently, buried near, but not immediately adjacent to, the 19.8-m-wide (65-ft-wide) road. The pipeline "footprint" was integrated with the road footprint into a 0.03 km-wide (100-ft-wide) road/pipeline development "corridor". The

road/pipeline corridor was assumed to be 80 km (50 mi) long. Consequently, direct impacts from pipeline/road construction are estimated to affect 2.45 km² (606 acres) of tundra habitat (Table 4.4.1.10-1).

The shore base and staging facilities were assumed to each have gravel footprints of 0.2 km² (50 acres) of tundra vegetation. As many as two pump stations would be needed to move oil, and these stations are estimated to each have a gravel footprint of 0.16 km² (40 acres).

Material to construct the road, shore base, and other facilities likely would come from upland gravel pits, if practicable, or from coastal areas (intertidal areas, barrier islands, etc.) if no feasible and prudent noncoastal alternative is available. The locations of gravel sources near a future alignment are unknown; however there is some potential that some known gravel sources (identified in NPR-A, presently undeveloped) or existing gravel pits would be used/expanded for material construction fill for the development facilities.

For the purposes of analysis, the MMS estimated that 0.40 km² of tundra vegetation would be affected by gravel extraction.

Overall, these developments are estimated to have a footprint of 3.41 km² (845 acres) (Table 4.4.1.10-1).

Secondary or indirect effects to tundra vegetation and wetlands would arise from overall modifications (altering drainage, inducing flooding, dust impacts, changes to thermokarsting patterns) and disturbances from traffic and human activities. The rationale for these calculations and the ecological basis for a zone of influence are detailed in those biological assessments and resultant biological opinions associated with waterfowl (specifically eiders) resources and are not repeated here. As eiders use tundra vegetation as nesting habitat, the MMS used the same zone of influence for impacts to tundra vegetation and palustrine wetlands. As with previous calculations, MMS calculations used a zone of influence away from developments measuring 200 m (656 ft). Our calculations did not take account the amount of overlap in the secondary effects zone that would occur where certain facilities meet. Overall, these zones of influence associated with development facilities have a collective areal extent of 33 km² (8,327 acres) in tundra vegetation and palustrine wetlands.

4.4.1.10.3.2. Anticipated Level of Effects from Discharges and Oil Spills. The potential effects of spills on tundra vegetation and wetlands were described in Section 4.4.1.10.2. According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas should be an infrequent occurrence. Vessels traversing the Chukchi and Beaufort seas during periods of ice are more prone to an accident. The ADEC (2007) reports that the highest probability of spills of noncrude products occurs during fuel-transfer operations at remote villages of the North Slope. (www.dec.state.ak.us/spar/perp/docs/10year_rpt/10Yr_Subareas_FINAL.pdf). Particular concern has been expressed over increases in tourism and shipping traffic between the Bering Sea and the North Atlantic, especially from vessels or crews unaccustomed or ill prepared to traverse these remote and dangerous areas.

Other sources of petroleum spills include a well blowout or other oil spills/toxics contamination from oil and gas exploration or development on State lease-lands in and near the Beaufort Sea. Discharges or spills of this nature are modeled as having a low percent chance of occurring, and it is improbable that adverse effects to tundra vegetation and palustrine wetlands would result. Variables determining whether discharges or oil spills would impact tundra vegetation and palustrine wetlands would depend largely on location and proximity of tidal wetlands and the confluence of particular waterways.

Impacts associated with discharges would be minimal and likely would be small quantities of diesel, gasoline, and hydraulic fluids spilled during maintenance and operation of equipment, suspended wells, or bottom-founded platforms. A pollution-prevention plan to minimize discharges directly into the water would be implemented. Due to potential low quantities of these discharges, negative impacts on shoreline vegetation communities would be negligible.

Due to amendments in the OCS Lands Act, strong safety and pollution-prevention regulations, and the use of blowout-prevention equipment installed on seabed wellheads, the potential for oil spills has diminished greatly. Therefore, impacts on shoreline vegetation would be expected to be low as a consequence of the implementation of these prevention measures. Another reason for diminished impacts of shoreline vegetation resulting from oil spills would be the distance from the shoreline in which the exploration activities take place.

4.4.1.10.3.3. Anticipated Level of Effects from Changes in the Physical Environment.

Arctic climate change could have effects on vegetation and wetlands that may surpass the impacts of other activities. Predicting impacts associated with continued arctic climate change is tenuous at best, but arctic climate change is projected to cause major shifts in vegetation complexes with rising temperatures favoring taller, denser vegetation. Wetland habitats may increase as a result of extensive thawing of permafrost and ground subsidence. Arctic tundra ponds and lakes are expected to lose water or completely dry up, which would result in the loss of established lake habitat. Capturing the full suite of processes impacting vegetation and wetlands as a result of arctic climate change is beyond the scope of this document.

Conclusions - Effects Under Alternative 1 to Vegetation and Wetlands. Marine and coastal areas of the North Slope are commonly perceived to be a pristine environment, yet there are a number of past and existing sources of harm, an increasing number of threats, and anticipated environmental changes that could negatively affect vegetation and wetlands in the project area well into the future, even if none of the proposed lease sales are held:

- Some important impacts to vegetation and wetlands will likely arise from continued climate change. Climate change can result in short- and long-term and beneficial or detrimental effects on coastal and marine habitats. Regardless of these potential effects, many specific ecological responses to climate change cannot be predicted, because new combinations of native and non-native species will interact in novel situations.
- Spills and discharges, especially within the tidal zone or in the proximity to existing deltas, pose the greatest risk to vegetation and wetlands. Existing and anticipated future increases in vessel traffic, especially from tourism or shipping, will increase the risk of a marine accident. Barring these events, deliveries of bulk fuel to coastal communities pose the greatest risk of a large, noncrude oil spill in the marine environment.
- Other factors such as mining, increases in human populations, and construction of all-season roads and other developments could compromise the integrity of existing aquatic and wetland ecosystems in the Arctic. The cumulative effects of these stresses will be far more serious than those by changing climate alone (Schindler and Smol, 2006).

4.4.1.10.4. Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts to vegetation and wetlands in the project area from Lease Sale 209 or 217 if they were not held. There would be no incremental contribution to cumulative effects from Alternative 1.

4.4.1.10.5. Cumulative Effects Under Alternative 1. There would be no cumulative impacts to vegetation and wetlands in the project area from Lease Sale 209 or 217 if they were not held.

4.4.1.11. Economy. The Impact Descriptor for economics is: economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased or decreased by 10% or more for at least 2 years. Economic well-being of residents is the ability of individuals and families to meet basic needs, which include food, clothing, housing, heat, and subsistence.

4.4.1.11.1. Direct and Indirect Effects Under Alternative 1. Without the action of the typical Beaufort sale, there would be delayed or no increases in NSB property taxes that would average about <4% above the level of NSB revenues without the sales in the peak years. There would be delayed no increases in revenues to the State of Alaska of <0.02% above the same level without the sale. There would be delayed or no increases in revenues to the Federal Government of <0.02% above the level without the sale in the peak years of production. For the NSB, State of Alaska, and the Federal Government, the increases would not taper off to even smaller percentages in the later years of production. There would be delayed or no change in total employment and personal income <0.9% over the baseline for the NSB and the rest of Alaska for each of the three major phases of OCS activity. Without the typical Beaufort sale there would be no contribution to extending the lifespan of TAPS.

Without a Beaufort lease sale there would be a continuation of global warming (e.g. a lease sale does not cause global warming). During the span of the 30 years of potential activity following a lease sale, we assume global warming would continue. We assume that global warming would cause sea levels to rise and the permafrost to melt to some degree. If this were a slight degree, there would be no effects on the economy in the NSB. However, if sea levels were to rise enough and permafrost melted enough, the effects on the economy in the NSB could be catastrophic in part, because the communities of the North Slope are, for the most part, near sea level. Only slight changes in sea level could flood the communities. Longer ice-free periods could cause greater coastal erosion and eventually erode the foundations of structures of the coastal communities. The villages of Shishmaref and Kivalina already are facing the serious issues of coastal erosion due to longer ice-free periods. Warming of the earth could affect continuous permafrost and, thus, affect the foundations of buildings. The solution to these problems is to rebuild the communities on higher ground with construction technology adapted to the changed permafrost conditions. This probably would cost from tens to hundreds of millions of dollars. These costs would be a severe and, perhaps, devastating shock to the economy in the NSB. Global warming could cause these effects to other communities in Alaska that are coastal and/or have permafrost. Other communities without these conditions are less likely to have these effects. For instance, Anchorage is on Cook Inlet and some of its low-lying area close to sea level would be affected. But most of the city is on higher ground and probably would not be affected by the rise in sea level. Anchorage does not have permafrost, so it would not be affected by changes in permafrost.

Unavoidable and Irreversible Commitment of Resources. For the economy, the commitment of human resources would be irreversible and irretrievable in the long and short term. That is, routine activity would generate employment at an enclave probably at the Prudhoe Bay complex for workers who otherwise would reside permanently primarily in Southcentral Alaska. Also, it would generate a small increase in resident employment in OCS-related activity in the NSB communities.

Synergistic Effects. There would be synergistic effects of both typical Chukchi and Beaufort lease sales and postlease activity occurring in approximately the same time period. The typical combined sales would generate increases in NSB property taxes that would average about <6% above the level of NSB revenues without the sales in the peak years. In the early years of production, the typical combined sales would generate increases in revenues to the State of Alaska of <0.03% above the same level without the sale. The peak years of production for the typical combined sales would generate increases in revenues to the Federal Government of <0.04% above the level without the sale. For the NSB, State of Alaska, and

the Federal Government, the increases would taper off to even smaller percentages in the later years of production. The change in total employment and personal income resulting from the typical combined sales would be <2.0% over the baseline for the NSB and the rest of Alaska for each of the three major phases of OCS activity. Assumed large oil spills of 1,500 bbl or 4,600 bbl would generate 120 or 180 jobs respectively for 6 months the first year, declining to zero by the third year following the spill, assuming the spills occurred in the same year. Typical combined Chukchi and Beaufort sales would contribute to extending the lifespan of the Trans-Alaska Pipeline with a total of 1 MMbbl instead of 500 MMbbl for each sale over an approximately 30-year period. Natural gas supplies from the Chukchi to communities along a North Slope pipeline route, such as Wainwright, Barrow, and Nuiqsuit could reduce the costs of electrical power generation.

Cumulative Effects.

Background. Without the activities considered in the cumulative-effects analysis, the onshore and offshore oil industry in and near Prudhoe Bay probably would decline. That is, exploration, development, and production and its associated direct employment could decline. Accordingly, associated indirect employment in Southcentral Alaska, Fairbanks, and the NSB and revenues to the Federal, State, and NSB governments could decline. Fluctuations in oil prices and other factors generated fluctuations throughout the Alaskan economy from 1975-1995 (McDowell Group, Inc., 1999). The Alaskan economy is not nearly as dependent on the oil sector as it was in the mid-1980s, when the major crash in the Alaskan economy occurred. Activities described in Sections 2.4.4. and 2.4.5 would generate employment, create economic opportunity, and add benefit to the cash economy of Alaska. The oil and gas industry with interests in and near Prudhoe Bay and the TAPS have a strong interest in using the pipeline system many years into the future. The pipeline system represents a tremendous capital investment. Extending the useful life of the pipeline allows society to receive returns from its investment further into the future than would be the case if oil development on the North Slope ceased. In November 2002, State and Federal agencies renewed the TAPS Right-of-Way was renewed for another 20 years. The oil and gas industry has reduced the costs of drilling wells and bringing new fields into production. This has made it more economic to develop fields that require more pipelines, both onshore and offshore, to connect to the existing pipeline system. Examples of this are the onshore pipelines that in recent years extended eastward and westward from Prudhoe Bay to the Badami and Alpine prospects, respectively. Future similar oil and gas infrastructure is possible in the Northeast and Northwest NPR-A (USDOJ, BLM and MMS, 1998, 2003). These onshore pipelines, and other possible future extensions proximate to the Beaufort Sea coast, make it more economic to develop offshore prospects. This can be done by extending pipelines northward to the offshore, including the OCS. The North Star development is an example of an extension of pipeline northward from previously existing pipeline infrastructure to the offshore. Section 4.2 provides a description of future development prospects and activities that potentially fit this geographic and economic pattern. These activities and those associated with Alternative 2, the Proposed Action, are the basis for the cumulative effects analysis.

Cumulative Effects to State and Local Revenues. The Northeast portion of the NPR-A alone would generate considerable revenues in the future. According to the final EIS for the Northeast NPR-A (USDOJ, BLM and MMS, 1998), oil from the Reserve at \$46 a barrel could generate additive annual revenues of \$72 million State and NSB share of royalty receipts, \$8 million property tax to the State, \$123 million severance tax to the State, and \$72 million Federal share of royalty receipts. For purposes of analysis, we presume that the \$72 million royalty receipts will be divided so that the State receives \$34 million and the Borough \$38 million. The Northwest portion of the NPR-A also would generate considerable revenues in the future. According to the final EIS for the Northwest NPR-A (USDOJ, BLM and MMS, 2003), oil from the Reserve at \$46 at barrel could generate additive annual revenues equal to the Northeast portion. Not counting the NPR-A, other components of the cumulative case could generate

the following additive annual revenues: \$38 million State share of royalty receipts, \$18 million State income tax, \$10 million State spill and conservation tax, \$105 million Federal share of royalty receipts, and \$143 million Federal income tax. In total, the cumulative case would generate the following additive annual revenues: \$82 million to the NSB and \$594 million to the State. \$3.1 billion to the Federal Government would include additive jobs in petroleum exploration, development, and production, plus oil spill cleanup.

Cumulative Effects to Employment and Personal Income. The cumulative gains in direct employment would generate indirect and induced employment and associated personal income for all the workers. This cumulative case is projected to generate additive employment and personal income increases as follows:

- 230 jobs annual average for NSB residents during development, declining to 50 during production. These include direct oil-industry employment, indirect, and induced employment.
- \$17 million in total average annual personal income for workers residing in the NSB during development, declining to \$4 million during production.
- 8,000 jobs annual average during development, declining to 4,400 during production. These jobs are for workers on the North Slope who reside in Southcentral Alaska and Fairbanks. These include direct oil-industry employment and indirect and induced employment.
- \$497 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to \$270 million during production.
- 21,800 jobs annual average during development, declining to 11,300 during production. These jobs are for workers who reside in the rest of the U.S. These include indirect and induced employment generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- \$1.2 billion in total average annual personal income for workers residing in the rest of the U.S. during development, declining to \$616 million during production. This income is for indirect and induced workers generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- 60-90 jobs for 6 months for cleanup of oil spills.

This information is derived from Section 4.4.2.11 of this EIS; the Beaufort Sea Multiple-Sale EIS (USDOJ, MMS, 2003a:Section IV.C.10); and economic effects analysis in the final EIS for the Proposed Program Outer Continental Shelf Oil and Gas Leasing Program 2007-2012 (USDOJ, MMS, 2007c).

4.4.1.12. Subsistence Harvest Patterns and Resources.

Summary. There would be no direct or indirect impacts to subsistence resources or harvests in the project area from Lease Sales 209 or 217 if they were not held. Without proposed mitigation in place, cumulative effects on subsistence resources and harvests from noise and disturbance would be major. To a large extent, existing stipulations and required mitigation have in the past mitigated such potential effects and may continue to do so. With an MMS-approved industry AMMP in place, effects would be reduced to moderate. Additionally, stipulated measures for seismic-survey permits and mitigation accompanying NMFS IHA plans generally ensure that acceptable levels of whale monitoring will occur. Together, these measures should ensure that no unmitigable adverse effects to subsistence-harvest patterns, resources, or practices will occur. Cumulative impacts from a large oil spill, when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together, would be considered major effects. If present rates of climate continue, impacts to subsistence resources and subsistence harvests would be expected to be major (USDOJ, MMS, 2007d).

The past and present condition of subsistence harvests and resources that could potentially be affected by the proposed Chukchi Sea and Beaufort Sea lease sales is described below, as well as the historic and present status of oil and gas development and other human activities on the North Slope and adjacent offshore areas (see Section 3). This is the baseline condition against which future impacts were evaluated. In the case of Alternative 1 No Lease Sale, the environmental consequence would be how the resource would be affected by reasonably foreseeable future events that did not include any lease sales proposed under this EIS. We determined the scope of the projects to include oil and gas development, other human activities, and environmental trends on the North Slope and adjacent offshore areas over the life of the proposed projects. Weighed more heavily are those activities that were more certain and closer in time and geography to the proposed lease-sale areas to keep the cumulative effects analysis concentrated on the effects in the proposed sale areas. Activities further away in time or farther from the lease sale areas were considered more speculative and not reasonably foreseeable. In this section, we consider activities or events that likely would occur regardless of leasing decisions made under this EIS. We primarily identify anticipated oil and gas exploration and development and production activities and projects in onshore and offshore areas of the Alaska North Slope.

Impact Assessment Overview. The coastal environment of the Beaufort and Chukchi seas contains important populations of whales, pinnipeds, fishes, and birds valued by subsistence hunters in the region. In the Beaufort Sea, river deltas, especially the Colville and McKenzie deltas, are important subsistence-resource areas, as is the barrier island environment. In the Chukchi Sea, pivotal habitats include the Chukchi polynya open-water lead system (important to migrating whales, other sea mammals, and birds); the shores and offshore waters of Capes Lisburne, Lewis, and Thompson (for seabirds); Ledyard Bay (for seabirds); Skull Cliff Kelp Beds (important marine habitat); Kasegaluk Lagoon (for nonsalmonid anadromous fish; birds, beluga whales, and spotted seals); Peard Bay (for birds, anadromous fish, spotted seals, and belugas); Kuk River Inlet (for anadromous fish); Pitmegea River and Thetis Creek deltas (for birds); and Point Hope Spit (for migrating birds). Cape Lisburne is an important walrus haulout site—the only major haulout site on the eastern Chukchi coast (Braund and Burnham, 1984). All of these biological resources and their subsistence harvests could be affected by the effects agents discussed above.

Factors Affecting Subsistence-Harvest Patterns and Resources. To understand effects on subsistence-harvest patterns in Kaktovik, Nuiqsut, Barrow, Atkasuk, Wainwright, Point Lay, and Point Hope, it is important to recognize three major conditions for these North Slope communities: (1) they rely heavily on sea mammals, particularly bowhead and beluga whales, walruses, bearded seals, caribou, and fishes in the annual average harvest; (2) community subsistence-hunting ranges overlap for many species harvested; and (3) subsistence hunting and fishing are central cultural values in the Inupiat way of life (see Tables 3.4.2-1 through 3.4.2-24; Stoker, 1983, as cited by Alaska Consultants, Inc. and S.R. Braund [ACI/Braund], 1984; S.R. Braund, 1989a,b; State of Alaska, Dept. of Fish and Game, 1993a,b; NSB Planning Dept., 1993; S.R. Braund and Assocs. and UAA, ISER, 1993a,b; Pedersen, 1995a,b; ADF&G, 1995c; Kaleak, 1996; S.R. Braund and Associates, 1996; Brower and Opie, 1997; Opie, Brower, and Bates, 1997; Brower, Olemaun, and Hepa, 2000).

Subsistence land use and harvest patterns often are different among villages because of differences in access to game and fish, village size, and traditional patterns of use. For example, bowhead whales generally are accessible to hunters only at Point Hope, Wainwright, and Barrow; cliff-nesting seabirds and eggs are available only near Point Hope. Barrow, situated where the Chukchi and Beaufort seas meet, has access to resource bases from each environment (Becker, 1987).

Because primary subsistence resources are migratory, the extent of potential impacts from oil exploration on subsistence hunting largely depends on the time of year that specific activity occurs and the location.

Subsistence activities are concentrated in time and space. Should exploration activities be coincident in time and space such that subsistence animals are frightened away or hunter access to the animals is hindered, the subsistence-hunting effort may not provide the expected returns (Becker, 1987). For example, drilling or seismic-survey activities that coincide in time and space with the use of the lead system by these animals and subsistence hunters could have potential detrimental effects (Braund and Burnham, 1984). The spring lead system in the Chukchi Sea is the only dependable open water available in spring; it is vital to subsistence hunters who hunt bowhead and beluga whales in the leads and seals, walrus, and other marine mammals that inhabit the retreating ice (Becker, 1987; USDO, MMS, 1987b, 1990b, 1997, 2003a, 2004).

The Cultural Importance of Subsistence. Eugene Brower testified in Barrow at the public teleconference for our draft EIS on the 1997-2002 5-Year Oil and Gas Leasing Program for the OCS. He asserted the importance of the subsistence harvest to Inupiat lifeways in the Chukchi and Beaufort Seas:

These two oceans produce the main food supply for the Inupiat people living off the two oceans. And these two oceans are our garden. They may not produce oranges or apples or sauerkraut or cauliflower, cattle, or chicken, but they produce the food that keeps us alive. You may not like how we eat it, but the good Lord put these animals in this region so that we, The Inupiat, can live off these animals. (Brower, 1996, as cited in USDO, MMS, 1996c)

Frank Long, Jr., President of the Nuiqsut Whaling Captains Association, expressed the importance of the bowhead whale hunt to the Inupiat way of life at an Arctic Synthesis Meeting we convened in Anchorage, Alaska, in 1995: “We know that whaling is dangerous, but it is our livelihood. We have to supply our community’s nutritional needs for the winter. The captain doesn’t get the whole whale; after it is harvested, it belongs to the whole community. We share it” (Long, 1996).

In 1994, Glenn Roy Edwards, whaler and Arctic Slope Regional Corporation official, related: “Without whaling, there would be no purpose to Barrow. I depend on my job; I like my job. But if it came down to a choice, I’d leave it to come out here and go whaling. I am first a whaler” (Balzar, 1994).

Effects Definitions and Effects Levels. The assessment of effects levels derives from a set of effects-level definitions that have been developed over many years by MMS anthropologists and socioeconomic specialists, and have withstood many professional and legal reviews. These definitions follow a two-tiered approach in that they account for effects to subsistence resources in addition to effects to subsistence harvests. Disturbance to subsistence is measured by the duration of effect to resources and harvests and by changes in availability, in desirability, and in resource population levels. The definitions used in this analysis consider:

1. Periodic, short-term effects that have no consequent effects to subsistence resources or harvests as the lowest level of effect (a *negligible* effect).
2. The next level of effect has subsistence resources or harvests being affected for a period up to 1 year (1 harvest season), but none of these resources would become unavailable, undesirable, or experience population reductions and, therefore, would not alter subsistence harvests (a *minor* effect).
3. The third level of effect has subsistence resources becoming unavailable, undesirable for use, or experiencing population reductions for a period up to 1 year (1 harvest season), with subsistence harvests being affected for that period. Affected subsistence resources and harvests would be expected to recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated (a *moderate* effect).

4. The highest level of effect is similar to the *moderate* effect definition, except affected subsistence resources and harvests would not be expected to fully recover even if proper mitigation is applied during the life of the proposed action or even if proper remedial action is taken once the impacting agent is eliminated (a *major* effect).

For subsistence resources, as the categories move from negligible to major, the timeframe of disruption increases, but the magnitude of the effect stays relatively constant (one or more important subsistence resource would become unavailable, undesirable, or available only in greatly reduced numbers). The categories have some overlap but have enough differences to allow the analyst to accurately describe the myriad potential effects into a single category.

In reporting the conclusions of our analysis for potential adverse effects from OCS activities, we shift from this four-category scale to a single standard to provide a clear boundary that when crossed, signals major effects. In part, the high category was selected to maintain continuity between our assessment of subsistence and sociocultural effects and the Environmental Justice significance threshold of disproportionately high adverse effects embedded in our assessment of human health and environmental effects of a proposed action on low income, minority populations under Executive Order 12898.

We intend the thresholds to be flexible, so they can be applied to diverse resources of the different Alaska OCS Region planning areas. We carefully and rigorously apply these criteria to circumstances within each planning area.

A major effect occurs if a single important resource becomes unavailable or undesirable for use or available only in greatly reduce numbers for 1 year. Please note that the use of “or” instead of “and” means that any one of the three conditions individually will result in a significant effect. This approach results in a fairly broad threshold. For example, the significance threshold would be met if OCS oil and gas activities resulted in one important resource becoming undesirable for use for a period of 1 year, regardless of how available the resource was. In the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), the analyses for Sales 186, 195, and 202 all used the lower threshold of 1 year and interpreted this to mean unavailable, undesirable for use, or available only in greatly reduced numbers for *one harvest season*.

The absence of a major effect does not equate to “no effect.” As shown in the four-category scale, and in the numerous analyses that we have undertaken, effects from activities can be adverse and noticeable before they reach a major threshold. Furthermore, in the cumulative effects analysis, we analyze the combined effects of projected activities with other actions because we know that effects that individually do not reach our major threshold can exceed that threshold when considered collectively.

4.4.1.12.1. Potential (Unmitigated) Effects to Subsistence Harvests and Resources. In the following analysis, we describe the potential effects to subsistence harvests and resources from a variety of existing sources. We then describe mitigation measures that would avoid or minimize some of these impacts. This analysis is organized by types of effects and by subsistence resource, and discusses effects on subsistence-harvest patterns from (1) vessel and aircraft noise and disturbance, (2) oil spills, (3) seismic surveys, (4) habitat loss, (5) other sources, (6) production activity, and (7) climate change. Analytical descriptions of affected resources and species in addition to indigenous Inupiat knowledge concerning effects are described in detail.

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns. These changes could occur as a result of oil spills and noise and disturbance from seismic surveys; aircraft and vessel traffic; drilling activities; pipeline construction; structure placement; and support-base,

pump-station, and gravel- and ice-road construction. The following analysis examines the effects of each of these disturbance agents on the subsistence resources harvested by the Inupiat living in the communities near the Beaufort Sea multiple-sale area. The Beaufort Sea Planning Area includes the marine subsistence-resource areas of Kaktovik, Nuiqsut, and Barrow, and this analysis includes the marine and terrestrial resources harvested by their residents. Atqasuk residents also harvest marine mammals but only in conjunction with Barrow whaling crews. All subsistence-harvest effects on marine mammals in Barrow also would occur in Atqasuk.

As noted in Section 3.4.2, onshore oil developments on the North Slope and associated fragmentation of resource habitats and harvest areas already have affected the subsistence-harvest system. Many of these effects are the indirect result of increased wage employment made available through projects and services funded by the NSB. Wage employment has led to an upgrading of hunting technology; alternatively, it has constricted the total time available for hunting. Additionally, development at Prudhoe Bay and Alpine has restricted access to traditional hunting areas in the vicinity. Currently, diminished household incomes, reduced by the loss of high earnings from the NSB Capital Improvements Projects (CIPs) period in the early to mid-1980s, tend to encourage subsistence-hunting activity and to foster an increase in harvest levels and an expansion of subsistence-harvest areas for many subsistence resources (Pedersen, 1997). Another effect on subsistence-harvest patterns has been the alteration of use areas due to Prudhoe Bay development. Pedersen (1998, pers. commun.) has indicated that Nuiqsut residents have altered their use patterns around Prudhoe Bay, and Nuiqsut residents confirm this. Another major change has been increased access to Deadhorse, via the Haul Road and beyond, provided by a winter ice road that has connected Nuiqsut and Prudhoe Bay for the last few years.

Offshore, local residents consistently have indicated that whales and other marine mammals are very sensitive to noise, and that they have been disturbed from their normal patterns of behavior by past seismic and drilling activities. Because of these perturbations, whales also can become less predictable and more dangerous to those who hunt them. Whalers from Kaktovik, Nuiqsut, and Barrow have been especially vocal on this issue, as they are most likely to be directly affected by such activities during the fall open-water season. Fenton Rexford (Kaktovik) stated that during exploratory drilling in Canadian offshore waters (to the east of Kaktovik, and where whales come from during their eastward fall migration when Kaktovik whalers hunt them) that “we were not successful or had a very hard time in catching our whale when there was activity with the SSDC [single steel drilling caisson], the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it difficult for our whalers to get our quota” (testimony cited in USDO, MMS, 1996d). Herman Aishanna reported that in 1985, the SSDC affected Kaktovik whaling even though it was idle – “We got no whales that year” (USDO, MMS, 2001). The late Burton Rexford related his experience of the effect of seismic activities on whaling in 1979-1981: “There were three of us captains that went out whaling in the fall. In those three years we didn’t see one bowhead whale, and we saw no gray whales, no beluga, and no bearded seal” (McCartney, 1995, cited in USDO, MMS, 1996d).

Tom Albert, a former non-Inupiat Senior Scientist for the NSB Department of Wildlife Management, related that: “When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about ‘spookiness;’ when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch” (USDO, MMS, 1997). This source also contains an entire session devoted to whaling captains’ observations on the effects of noise on whales and whaling (USDO, MMS, 1997). That marine mammals are sensitive to noise disturbance is clear, although thresholds in terms of signal characteristics and distance for each species have not been established. Past industry activities have been effectively limited in specified areas during critical periods of subsistence use through industry/subsistence user cooperation. Generally, such effects would be localized to the vicinity of the seismic vessel, the construction site, or the drilling/production unit, and to the actual time of

operation. In the recent past, lease stipulations and other “non-disturbance” agreements dealing with whaler/oil industry conflicts with resources and hunting practices have tended to minimize such problems, yet recent legal action against MMS and NMFS would suggest this mitigative regime is not perceived as effective by local subsistence users.

4.4.1.12.1.1. Potential Effects from Vessel Disturbance. For more than 30 years, representatives of the NSB, the Alaska Eskimo Whaling Commission (AEWC), the Northwest Arctic Borough (NWAB), local tribal and city governments, and individual subsistence hunters have made their concerns clear about the potential impact of OCS exploration and development activity in the form of a list of community-specific issues: bowhead whales (problems related primarily to noise); interference with the spring hunt; seaward displacement of the fall migration route. Hunters believe this displacement has happened before and can happen again and that noise—especially that associated with seismic exploration—can push whales seaward by the time they get to Barrow (Becker, 1987; USDO, MMS, 1987b, 1990b, 1997, 2003a, 2004).

To varying degrees, subsistence resources and harvests can be impacted by geophysical seismic-exploration activities: vessel movements and traffic (seismic vessels, support vessels, ice-management vessels, etc.) could adversely affect the biological resources of the Chukchi and Beaufort seas, including those depended on by Alaskan Natives for subsistence, if protective mitigation measures are not incorporated in to seismic operation plans. Potential effects from noise and disturbance associated with vessel movements could affect whaling, sealing, bird hunting, and fishing in the spring and open-water season. Access to subsistence resources, subsistence hunting, and the use of subsistence resources also could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns. Current Western scientific research indicates bowheads do not seem to travel more than a few kilometers out of their original swimming direction due to noise-disturbance events, and that these changes in swimming direction are temporary, lasting from a few minutes in response to vessel noise. Traditional Inupiat observation and experience affirms that whales are affected by noise at greater distances and alter their swimming directions for longer periods (USDO, MMS, 1987a,b, 2001, 2003a).

Bowhead Whales. Bowheads may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mi). Marine-vessel traffic also may included seagoing barges transporting equipment and supplies to the North Slope, most likely between mid-August and mid- to late September. If barge traffic occurs into September, some bowheads may be disturbed. Fleeing behavior from vessel traffic generally stops within minutes after the vessel passes, but scattering may persist for a longer period. In some instances, at least some bowheads return to their original locations. In many cases, vessel activities are likely to be in shallow, nearshore waters outside the main bowhead-migration route. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident, and behavioral changes are temporary, lasting from few minutes in the case of vessels and aircraft, to up to 30-60 minutes in the case of seismic activity in earlier seismic studies. Occasional and brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migration between the central Bering and eastern Beaufort seas. We do not believe these disturbance or avoidance factors will be significant, because the level of industrial activity anticipated is not sufficiently intense to cause repeated displacement of specific whales. Overall, bowhead whales exposed to noise-producing activities such as vessel disturbance most likely would experience temporary, nonlethal effects, and some avoidance behavior could persist up to 12 hours. Recent acoustic studies indicate that bowheads showed behavioral changes from recorded drilling and icebreaker noise at levels 20 dB or more above ambient levels.

Whales could react to nonseismic-survey-related icebreaking noise at distances ranging from 2-25 km. An increase in exploration, development, and production results in a greatly increased amount of marine vessel activity including icebreakers, barges, sealifts, seismic vessels, supply boats, crew boats, and tugs. Whales respond strongly to vessels directly approaching them. Avoidance of a vessel usually begins when a rapidly approaching vessel is 1-4 km away, with a few whales possibly reacting at distances from 5-7 km. Received noise levels as low as 84 dB re 1 μ Pa, or 6 dB above ambient, may elicit strong avoidance of an approaching vessel at a distance of 4 km. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Icebreaker-response distances vary. Predictions from models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km, with roughly half of the bowhead whales showing avoidance response to an icebreaker underway in open water at a range of 2-12 km when the sound-to-noise ratio is 30 dB, and roughly half of the bowhead whales showing avoidance response to an icebreaker pushing ice at a range of 4.6-20 km when the sound-to-noise ratio is 30 dB. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Noise and disturbance from aircraft and vessel traffic would have localized, short-term effects that would cause some disruption to the harvest but would not cause bowheads to become unavailable to subsistence hunters (USDOI, MMS, 2006a).

Beluga Whales, Seals, Walruses, and Polar Bears. Brief disturbances to small numbers of beluga whales, seals, and polar bears occur from past and present vessel-traffic activities, with recovery from any disturbance event generally occurring within <1 day. Icebreakers briefly could disrupt some seal concentrations for up to a few days within a lead system, temporarily interrupt their movements, or temporarily displace some animals when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or significantly delay their migrations. Scientific and local Native knowledge of the behavior of nonendangered marine mammals and the nature of noise associated with offshore oil and gas activities suggest that intense noise causes startle, annoyance, and flight responses of seals, beluga whales, and polar bears. Supply-boat and other vessel traffic associated with exploration and seismic vessels operating during the open-water season temporarily could displace or interfere with marine mammal migration and change local distribution for a few hours to a few days and disturb bearded, ringed, and spotted seals hauled out on the ice or beaches along the coast. Such short-duration and local displacement (within 1-3 km [0.62-1.9 mi] is expected to have a short-term (less than a few days') effect on the distribution of seals, beluga whales, and polar bears.

Icebreakers briefly could disrupt some seal concentrations for up to a few days within a lead system, temporarily interrupt their movements, or temporarily displace some animals when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or significantly delay their migrations. Noise and disturbance from vessel traffic would have localized, short-term effects that would cause some disruption to the harvest but would not cause seals to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDOI, MMS, 1987c 1995a, 1998a; USDOI, BLM, 2005).

Even a brief disturbance response from vessel noise might temporarily interrupt the movements of belugas or temporarily displace some animals when vessels pass through an area. Such events could interfere especially with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where the community of Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters. Additionally, there is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Inupiat hunter access. For example, Point Lay residents rely on the harvest of belugas more than any other Chukchi Sea village and, at the present time, they are very successful at herding these animals by boat into Kasegaluk

Lagoon where they are then hunted. If noise from boat-traffic activity increased and the belugas acclimated to the noise, there is the possibility that this herding technique would be less successful and the hunt reduced.

Belugas generally do not get close enough to icebreakers for potentially harmful effects to occur. However, if the animals are engaged in important behavior such as mating, nursing, or feeding, they might not flee and might tolerate louder noises. Problems can arise in heavily industrialized areas where a variety of noisy activities take place. Cumulative noise levels could be very high for long periods of time and cover such large areas that animals might be either permanently displaced or adversely affected, because they have nowhere to flee to (Erbe and Farmer, 2000). Overall, noise and disturbance from vessel traffic would have localized, short-term effects that could cause some disruption to the harvest but would not cause belugas to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998a; USDO, BLM, 2005).

Oil and gas activities that occur during ice-minimum conditions in summer in the Chukchi Sea are likely to come into direct contact with adult females and subadult walrus (Jay et al., 1996). If disturbance causes walrus to abandon preferred feeding areas or interferes with calf-rearing, resting, or other activities, then the walrus population could be negatively affected. Walrus will flee haulout locations in response to disturbance from ship traffic although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances. Brueggeman et al. (1991) reported that 81% of walrus encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walrus may be tolerant of ship activities and movements. However, ice-management operations are expected to have the greatest potential for disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Overall, noise and disturbance from vessel activity is expected to have localized, short-term effects that could cause some disruption to the walrus harvest but would not cause walrus to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998a; USDO, BLM, 2005).

Vessel traffic associated with past or ongoing oil activities is not a major source of impacts to polar bears, because they show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Icebreaker noise would result in short-term, local displacement on polar bear migrations and distributions and such localized, short-term effects would cause some disruption to the subsistence harvest but would not cause polar bears to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998a; USDO, BLM, 2005).

Birds. Vessel-noise disturbance could displace birds from the local areas where disturbance events are occurring. Little direct mortality is expected, but losses of eggs and young to predators when adults are displaced is likely to occur. Disturbed adults routinely may experience lowered fitness, with resulting declines in survival and productivity. Recovery of losses to bird populations adversely affected by all sources of disturbance and habitat alteration is expected to occur within a few generations. Localized, short-term effects would cause some disruption to the subsistence harvest of birds but would not cause them become unavailable to subsistence hunters (Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998a; USDO, BLM, 2005).

4.4.1.12.1.2. Potential Effects from Aircraft Disturbance. Current Western scientific research indicates bowheads do not seem to travel more than a few kilometers out of their original swimming direction due to noise-disturbance events, and that these changes in swimming direction are temporary, lasting from a few minutes for aircraft. Traditional Inupiat observation and experience affirms that whales are affected by noise at greater distances and alter their swimming directions for longer periods.

Bowhead Whales. An increase in exploration, development, and production also results in greatly increased aircraft traffic. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise. Bowheads are not affected much by any aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior might occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). The effects from such an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales should resume their normal activities within minutes. Occasional and brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migration between the central Bering and eastern Beaufort seas. However, given the extremely high number of helicopter flights documented to support Northstar, bowheads may be exposed repeatedly helicopter noise in areas between shore bases and/or airports and the production facilities. Overall, bowhead whales exposed to noise-producing activities such as aircraft traffic most likely would experience temporary, nonlethal effects, and some avoidance behavior could persist up to 12 hours.

Beluga Whales, Seals, Walruses, and Polar Bears. Some potential noise and disturbance from aircraft traffic could occur along the coast. The primary source of noise and disturbance would come from air traffic along the coast of the planning areas, specifically from helicopters and other aircraft associated with ongoing onshore oil-exploration activities. Such events could interfere especially with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where the community of Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters. Aircraft traffic centered out of Deadhorse-Prudhoe Bay traveling to and from NPR-A exploration facilities is assumed to be a potential source of disturbance to ringed or spotted seals hauled out on the ice or beaches along the coast and to polar bears using coastal habitats. Although air-traffic disturbance would be very brief, the effect on individual seal pups could be severe. Aircraft disturbance of small groups of spotted and ringed seals hauled out along the coast is not likely to result in the death or injury of any seals, although increases in physiological stress caused by the disturbance might reduce the longevity of some seals if disturbances were frequent. Polar bears could experience short-term, localized aircraft-noise disturbance—effects that would cause some disruption in their harvest—but this is not expected to affect annual harvest levels (Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998a; USDO, BLM, 2005; USDO, BLM and MMS, 2003).

Aircraft traffic (particularly helicopter trips) is assumed to be a potential source of disturbance to bearded, ringed, and spotted seals hauled out on the ice or beaches along the coast. Air-traffic disturbance would be very brief and would disturb small groups of seals hauled out along the coast. The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed from their haulouts and enter the water, although their responses will be highly variable and brief in nature. The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed from their haulouts and enter the water,

although their responses will be highly variable and brief in nature. Such effects would cause some disruption to the seal harvest but would not cause seals to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDOl, MMS, 1987c 1995a, 1998a; USDOl, BLM, 2005).

Walrus will flee haulout locations in response to disturbance from aircraft, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea-ice habitats have reported little reaction to aircraft above 1,000 ft (305 m). The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed from their haulouts and enter the water, although their responses will be highly variable and brief in nature. Overall, noise and disturbance from aircraft is expected to cause some disruption to the walrus harvest but would not cause walrus to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDOl, MMS, 1987c 1995a, 1998a; USDOl, BLM, 2005).

Birds. The noise and presence of aircraft operating at low altitudes, especially helicopter traffic, have the potential to disturb birds. Birds would flush or move away from the noise and approaching aircraft. There is an energetic cost to repeatedly moving away from aircraft disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Aircraft disturbance could displace birds from the local areas where disturbance events are occurring. Little direct mortality is expected, but losses of eggs and young to predators when adults are displaced is likely to occur. Disturbed adults routinely may experience lowered fitness, with resulting declines in survival and productivity over the life of the field. Recovery of losses to bird populations adversely affected by all sources of disturbance and habitat alteration is expected to occur within a few generations. Localized, short-term effects would cause some disruption to the subsistence harvest of birds but would not cause them become unavailable to subsistence hunters (see Section 4.4.1.7, Marine and Coastal Birds; Braund and Burnham, 1984; USDOl, MMS, 1987c 1995a, 1998a; USDOl, BLM, 2005).

Caribou and Other Terrestrial Mammals. With increased activity from onshore development, aircraft traffic passing overhead of caribou and other terrestrial mammals (muskoxen, grizzly bears, and arctic foxes) during flights to and from onshore construction areas and along aerial-survey routes, exposes a greater number of individual animals to human activities. Aircraft produce very brief (few minutes to <1 hour) disturbance effects on caribou, muskoxen, grizzly bears, and arctic foxes, with recovery occurring within a day or less and to have no effect on their populations. Effects on caribou, muskoxen, and grizzly bears likely would be local displacement within about 4 km of onshore pipelines and roads. Localized, short-term effects would cause some disruption to the harvest but would not cause caribou and other terrestrial mammals to become unavailable to subsistence hunters (Braund and Burnham, 1984; USDOl, MMS, 1987c 1995a, 1998a; USDOl, BLM, 2005).

4.4.1.12.1.3. Potential Effects from Discharges. For exploration wells, because of the high cost of synthetic drilling fluids now commonly used, it is assumed that 80% of the drilling mud will be reconditioned and reused. Only 20% (an estimated 95 tons) of “spent mud” per well will be discharged at the exploration site. All of the rock cuttings will be discharged at the exploration site. For production wells all waste products (drilling mud, rock cuttings, and produced water) for on-platform wells will be treated and then disposed of in shallow wells on the production platform. For the surrounding subsea wells, drilling waste products could be barged to a coastal facility for treatment and disposal.

Drilling muds, cuttings, and other discharges are covered under the EPA’s NPDES General Permit for Oil and Gas Exploration (Permit No. AKG280000) for the Beaufort and Chukchi seas (see Sec.4.4.1.1, Water

Quality). The permit, using EPA’s Ocean Discharge Criteria, seeks to determine if activities will cause unreasonable degradation of the marine environment, specifically as they relate to (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities, and (2) the threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.

Effects from Discharges to Subsistence Resources. The NPDES General Permit concludes that impacts from exploratory oil drilling operations “based on the limited areal extent of impacts in relation to the total lease area containing prey, and the mobility of these species, impacts are judged to be minimal.” For human health:

Overall, significant impacts to human health are not expected to result from the limited discharges of drilling mud that characterize the exploratory phase in the Arctic lease sales. The hazard associated with consuming fish and shellfish contaminated with metals or petroleum hydrocarbons is expected to be low. The reasons for this assessment are: bioconcentration factors for heavy metals other than methylmercury and for mobile aromatic hydrocarbons such as benzene are too low to warrant concern about biomagnification; mercury, which is potentially the most hazardous metal, is a relatively minor constituent of drilling muds; and the areas affected by exploratory drilling discharges are too small to contribute substantially to the diet of fish or shellfish harvested by fisheries (EPA, 2005).

Based on this assessment, effects from discharges on marine species such as bowhead whales, beluga whales, seals, walruses, marine fish, marine birds, and polar bears are not expected to contaminate these species, disrupt the harvest, or cause them to become unavailable to subsistence hunters.

4.4.1.12.1.4. Potential Effects from Oil Spills.

4.4.1.12.1.4.1. Large Oil Spills.

General Effects from Oil Spills. Exposure of subsistence resources and harvest to oil spills could result from a number of ongoing or future activities. These include vessel sinkings or accidents, equipment malfunctions during bulk-fuel transfers, and during oil and gas exploration and development.

General effects could be expected from potential oil spills and tainting and the cleanup disturbance that could occur after such a spill event. An oil spill affecting any part of the migration route of the bowhead whale could taint a resource that is culturally pivotal to the subsistence lifestyle. Even if whales were available for the spring and fall hunts, tainting concerns could leave bowheads less desirable and alter or stop the subsistence hunt. Communities unaffected by a potential spill would share bowhead whale products with impacted villages, and the harvesting, sharing, and processing of other resources should continue. Concerns about tainting also would apply to polar bears and seals and, in the event of a large oil spill, could cause potential short-term but serious adverse effects to some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Oil-spill-cleanup activities could produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters.

Although a spill could originate within the Beaufort Sea and Chukchi Sea Planning Areas, its indirect impacts might be felt by communities remote from the lease-sale areas and far removed from the spill. Essentially, concerns about subsistence harvests and subsistence food consumption would be shared by all Inupiat and Yup’ik Eskimo communities in the Chukchi and Bering seas adjacent to the migratory corridor used by whales and other migrating species. Tainting concerns in these communities about resources initially and secondarily oiled could seriously curtail traditional practices for harvesting,

sharing, and processing important subsistence species, because all communities would share concerns over the safety of subsistence foods in general and whale food products and the health of the whale stock, in particular.

4.4.1.12.1.4.1.1. Specific Effects to Subsistence Resources.

Bowhead Whales. In the event of a large oil spill, the probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead habitat. If a spill occurred and contacted bowhead habitat during the fall migration, it is likely that some whales would be contacted by oil. It is unknown what effects an oil spill would have on bowhead whales, but some conclusions can be drawn from studies that have looked at the effects of an oil spill on other types of whales. It is likely that some whales would experience temporary, nonlethal effects, including one or more of the following symptoms: (1) oiling of their skin, causing irritation; (2) inhaling hydrocarbon vapors; (3) ingesting oil-contaminated prey; (4) fouling of their baleen; (5) losing their food source; and (6) temporary displacement from some feeding areas.

Some whales could die as a result of contact with spilled oil. Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales, and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age and degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales. There is uncertainty about effects on bowheads (or any large cetacean) in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within the proposed sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed, and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales or their feeding areas from an oil spill.

Barrow elder Thomas Brower, Sr., observed an oil spill from a U.S. Navy vessel in the Plover Islands east of Barrow in 1944 where about 25,000 gal were spilled. According to Brower: “for four (4) years after that oil spill, the whales made a wide detour out to sea from these islands. Those Native families could no longer hunt whales during these years at that location” (Brower, as cited in NSB, Commission on History and Culture, 1980).

Although this spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, the event is remembered more importantly as a time of devastation and deprivation by those who directly witnessed the effects of the spill or those who were told of the event by witnesses. Not only were whales absent for 4 years following the spill, but other resources were absent or occurred in reduced numbers. The people of Barrow who remember the spill consider it evidence that even a relatively small oil spill in a defined area can have lasting effects on subsistence resources and harvests.

Thomas Brower, Sr. stated that:

In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area—the Plover Islands—became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear (Brower as cited in NSB, Commission on History and Culture, 1980).

Again, it should be noted that some species' recovery was seen after 4 years.

Onshore pad or pipeline spills are not expected to impact migrating bowhead whales whose migration route typically is well offshore of onshore locations where oil and gas development is likely to occur. A spill occurring in Dease Inlet related to NPR-A activities would be expected to disperse before it reached migration routes and offshore habitats, where bowhead whales could potentially be exposed to the spill.

Beluga Whales, Seals, Walruses, and Polar Bears. The effects from a large spill on beluga whales, seals, and polar bears would occur from: (1) oiling of skin and fur; (2) inhaling hydrocarbon vapors; (3) ingesting oil-contaminated prey; (5) losing food sources; and (6) temporary displacement from some feeding areas. The Beaufort Sea multiple-sale final EIS estimated the likely losses at 300 ringed seals, 10-20 spotted seals, and 30-50 bearded seals, fewer than 100 walruses, perhaps 5-30 polar bears, and fewer than 10 beluga and gray whales. Populations were expected to recover within about 1 year. These estimates were made before the accelerated loss of arctic sea ice had been documented and before initiatives for listing these species as threatened or endangered, as a result of this ice loss, had occurred.

For beluga whales, as with bowhead whales, there is uncertainty about effects on them in the event of a very large spill. There are, in some years and in some locations, relatively large aggregations of feeding and molting whales. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects could be greater than typically assumed; and population-level effects cannot be ruled out, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that whales would be likely to suffer significant population-level adverse affects from a large spill originating in the sales' area. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. For walruses, an oil spill impacting haulout areas could have a significant impact on the Pacific walrus population, although the chance of contact to haulout areas is small. Little information is known about oil-spill effects on seals, although any large oil spill in nearshore marine or coastal riverine environments could cause injury or death to these sea mammals, potentially cause them to move off of their normal course, and make them unavailable for subsistence harvest.

For polar bears, if an offshore oil spill occurred, a major impact to polar bears could result, particularly if areas in and around polar bear aggregations were oiled. This is because the biological potential for polar bears to recover from any perturbation is low due to their low reproductive rate and rapid loss of sea ice habitat due to global climate change.

Caribou and Terrestrial Mammals. Caribou can frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and could become oiled or ingest contaminated vegetation. During late winter-spring, caribou move out on to the ice and lick sea ice for the salt and could be

exposed to oil if a spill contaminates the ice. Caribou that become oiled are not likely to suffer the loss of thermoinsulation through fur contamination, although toxic hydrocarbons could be absorbed through the skin and also could be inhaled. Significant weight loss and aspiration pneumonia leading to death are possible adverse effects of oil ingestion in caribou. Caribou that become oiled by contact with a spill in coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin. Similar effects would be expected for muskoxen. Grizzly bears depend on coastal streams, beaches, mudflats, and river mouths during the summer and fall for catching fish and finding carrion. If an oil spill contaminates beaches and tidal flats along the Chukchi Sea or Beaufort Sea coastlines, some grizzly bears and arctic foxes are likely to ingest contaminated food, such as oiled birds, seals, and other carrion. Such ingestion could result in the loss of at least a few bears and a few foxes through kidney failure and other complications. An oil spill in a coastal river would have greater impacts to local grizzly bear populations, particularly if it occurred during an active salmon run. For the most part, the effect of onshore pipeline spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou and muskox range within pipeline corridors.

If a platform or pipeline oil spill occurred during the open-water season or during winter and melted out of the ice during spring, some caribou frequenting coastal habitats could be directly contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities. However, even in a severe situation, a comparatively small number of animals—perhaps a few hundred—are likely to be directly exposed to the oil spill and die as a result of toxic hydrocarbon inhalation and absorption. This loss probably would be small to the overall population of a particular caribou herd.

Fish. A large oil spill impacting intertidal or estuarine spawning and rearing habitats used by capelin or other fishes potentially could result in significant adverse impacts to some local breeding populations. Recovery to former status by dispersal from nearby population segments would require more than three generations. Given a lack of contemporary abundance and distribution information, large oil-spill effects on rare or unique species (including potential extirpation) could occur but likely would go unnoticed or undetected. Depending on the timing, extent, and persistence of a large spill, some distinct runs of pink and chum salmon could be eliminated. Recovery from this significant adverse impact would occur only as strays from other populations colonized the streams after the oiled habitats recovered. These local fish stocks would not be available for subsistence harvest for many years.

Birds. The greatest potential for substantial adverse impacts on marine and coastal birds typically would come from large volume oil spills in important coastal bird habitats. These areas are coastal lagoons, barrier islands, the spring open-water lead system, and seabird-nesting colonies. Oil spills have the greatest potential for affecting large numbers of birds, in part due to toxicity to individuals and their prey and the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large number of murre, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in significant adverse impacts to the colonies. Similarly, large-scale mortality could occur to pelagic distributions of auklets and shearwaters during the open-water period and male and juvenile murre in the late summer. In the Chukchi Sea Planning Area, Kasegaluk Lagoon, Peard Bay, colonies at Cape Thompson and Cape Lisburne, the open-water spring-lead system, and barrier islands provide important nesting, molting, and migration habitat to a variety of waterfowl and shorebirds. Spills during periods of peak use could affect large numbers of birds. Up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected if an oil spill reached Kasegaluk Lagoon. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45% of the Pacific Flyway population would have conspicuous population-level effects. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi and Beaufort seas.

4.4.1.12.1.4.1.2. Specific Effects to Subsistence-Harvest Patterns. Oil spills probably are the most significant potential source of adverse effects attributable to North Slope activities both on- and offshore. Large spills could affect subsistence patterns by reducing populations of subsistence species, contaminating subsistence species or their habitats, or rendering resources unfit to eat. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users were required to travel farther to obtain subsistence resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion (USDOI BLM and MMS, 2003; USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004a, 2006a,b,d).

Major negative impacts to specific subsistence species, as well as to the more general patterns of subsistence-resource use, persisted in Prince William Sound for several years after the *Exxon Valdez* oil spill (EVOS) event and the subsequent cleanup effort. The EVOS event demonstrated that a very large spill could affect Prince William Sound, as well as the east coast of the Kenai Peninsula and the beaches of the Kodiak/Shelikof Strait area. Such effects would reduce the availability and/or accessibility of subsistence resources, typically for a single season or less, but potentially for longer periods.

The impacts of both large and small oil spills are expected to be major in the Arctic. An oil spill of more than 1,000 bbl, depending on the time and location of the spill event, could affect the subsistence use of marine mammals in the region. Marine mammals are the most important subsistence resource, both conceptually and as food, for these regions. The bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and longer hunt for walrus. Animals could be directly oiled, or oil could contaminate the icefloes they use on their northern migration. Contaminated animals would be considered undesirable and could be more difficult to hunt because of the physical conditions. Animals could be “spooked” and/or wary, either because of the spill itself or of the “hazing” of marine mammals, which is a standard spill-response technique used to encourage them to leave the area affected by a spill. There has been little experience with under-ice or broken-ice oil spills, and local residents have little confidence in industry’s current capability to successfully clean a spill of this type up in a timely manner.

While the concern is most typically phrased in terms of the potential effects of oil spills on whales and whaling, it also is a more generalized concern for marine mammals and ocean resources in general. Marine mammals and fish typically comprise 60% of a coastal community’s diet, and the ocean is frequently referred to in public testimony as “the Inupiat garden.” Pipeline and platform spills also could impact migrating anadromous fish in the river deltas, as well as species that use (potentially oiled) coastal and nearshore habitat (nesting birds, breeding caribou, etc.). Dependent on the size, location, and timing of a potential spill impacts would vary, however, overall, large oil-spill impacts on subsistence practices and resources would be considered major.

Oil-spill contact in winter could affect polar bear hunting and sealing. Contact during the open-water season could affect bird hunting, sealing, and whaling, as well as the netting of fish in the ocean. The potential for bowhead whales to be contacted directly from an oil spill is relatively small, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas is considerably greater. Onshore areas and terrestrial subsistence resources, in general, seem to have a lower potential for oil-spill contact.

Major effects would be expected to occur on subsistence-harvest patterns from a large oil spill, as important subsistence resources would become unavailable, undesirable for use, or available only in greatly reduced numbers for at least one harvest season.

Oil spills would affect subsistence *resources* periodically in regional subsistence communities. In the event of a large oil spill, many harvest areas and some subsistence resources would become unavailable

for use. Some resource populations would suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads and threaten a pivotal element of Inupiat culture.

There also is concern that the IWC, which sets the quota for the Inupiat subsistence harvest of bowhead whales, would reduce the harvest quota following a major oil spill or, as the migration corridor becomes increasingly developed, to ensure that overall bowhead whale population mortality did not increase. Such a move would have a profound cultural and nutritional impact on Inupiat whaling communities. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages, and harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree these resources were contaminated. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters.

Tainting concerns also would apply to beluga whales, walrus, polar bears, seals, fish, and birds. All areas directly oiled, areas to some extent surrounding them, and areas used for staging and transportation corridors for spill response would not be used by subsistence hunters for some time following a spill. Oil contamination of beaches would have a profound impact on whaling because, even if bowhead whales were not contaminated, Inupiat subsistence whalers would not be able to bring them ashore and butcher them on a contaminated shoreline. Because all communities would share concerns over the safety of these subsistence foods and the health of the whale stock, social stress would occur from the reduction or loss of preferred foods harvested in the traditional fashion and threaten a pivotal element of indigenous Alaska culture. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the persistence of oil in the environment, the degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. Such oil-spill effects would be considered major.

Concerns about tainting also would apply to polar bears and seals and could cause potential short-term but serious adverse effects to some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Oil-spill-cleanup activities could produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters. A spill originating within the Chukchi Sea region could produce indirect impacts felt by communities remote from the spill area and far removed from the spill. Concerns about subsistence harvests and subsistence food consumption essentially would be shared by all Inupiat and Yup'ik Eskimo communities in the Chukchi (including indigenous people on the Russian Chukchi Sea coast) and Bering seas adjacent to the migratory corridor used by whales and other migrating species.

Onshore, the greatest potential impact from a large spill would result if the spill occurred in the spring, just before breakup, and resulted in a release of crude oil into a river or stream below the ice which, in turn, was released during breakup into the nearshore coastal waters of the Chukchi Sea. If oil were spilled in a waterway in large volumes, waterfowl, fish, and marine mammals could be fouled, contaminated, or killed. A large spill would be toxic immediately to fish and could contaminate them for years, even in apparently cleaned habitats. Waterfowl and marine mammal populations could be affected by the death of animals from hypothermia caused by oiling, reactions to toxic components of spilled oil, and gastric distress resulting from attempts to clean themselves. In addition, scavengers feeding on their remains, such as foxes, also could be harmed.

A large onshore spill from NPR-A-related activities would not be expected to impact migrating bowhead whales. An offshore spill occurring in Dease Inlet would be expected to disperse before it reached bowhead migration routes and offshore habitats, where bowhead could potentially be exposed to the spill.

Some seals could be exposed in a Dease Inlet spill during the open-water season and result in losses, but the population likely would replace this loss in 1 year. If the spill occurred during spring breakup, ringed seal losses could be expected, with the overall population replacing this loss in 1 year. A Dease Inlet spill is not expected to affect bearded seals, walruses, or beluga and gray whales, because these species tend to occur offshore of Dease Inlet and Admiralty Bay; such a spill is expected to disperse before it reached offshore habitats and migration routes where these species could be exposed. Food-chain effects on these marine mammals are not likely.

4.4.1.12.1.4.2. Small Oil Spills. Effects could occur if oil is released through leaks and faulty valves. Small spills, although accidental, generally are routine and expected. The causes of chronic low-volume oil spills are leaking tanks, faulty valves/gauges, vent discharges, faulty connections, ruptured lines, seal failures, human-error accidents during loading and offloading, flushing of tanks and bilges, and explosions. The cause of approximately 30% of the spills is unknown. Most small spills that occur are contained and do not reach the environment (ADEC, 2001).

Small spills occur offshore on drilling structures and onshore on gravel pads near pipeline tie-in locations. Because of the small size of these spills and their expected containment onsite, effects on subsistence resources likely would be negligible, although this would depend on the context of the spill, the area covered by spilled product, and the amount of time the product was in the environment before cleanup efforts began. Oil spills in winter on snow or frozen tundra typically would be contained and cleaned up relatively quickly; spills in summer that were not contained would be quite difficult to clean up and would have lingering impacts on the impacted tundra, regardless of the area covered. It might be impossible to completely clean up spills that reached or occurred in waterways, in open water, or broken ice. Offshore spills should have minimal effects on marine mammals, as onshore spills should have minimal effects on terrestrial mammals. Overall, accidental small oil spills periodically could affect subsistence resources (USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998a, 2001b, 2003a, 2004, 2006b,d).

4.4.1.12.1.4.2.1. Effects from Small Oil Spills to Subsistence Resources.

Bowhead Whale, Beluga Whale, and Other Marine Mammals. Small offshore oil spills should have minimal effects on marine mammals because of their expected containment onsite, minimal contact with habitat, and, their brief persistence in the environment due to their size and to environmental weathering. There potentially could be displacement of bowhead whales from a local feeding area following a fuel spill, and this displacement could last as long as there is a large amount of oil and related cleanup-vessel activity. Individual bowhead whales potentially could be exposed to spilled fuel oil, and this exposure could have short-term effects on health. Outside of a major fuel spill resulting from a vessel sinking, we expect seismic-survey spill-related effects to be minor. For beluga whales, if a small oil/fuel spill were to occur, it would be easily avoidable by them; impacts, if any, most likely would include temporary displacement until cleanup activities are completed and short-term effects on health from the ingestion of contaminated prey. The spill event described by Barrow elder Thomas Brower, Sr., caused by a U.S. Navy vessel in the Plover Islands east of Barrow in 1944, caused whales to make a “wide detour out to sea from these islands” for 4 years. The whale hunt was curtailed for that time at that location. Also, he observed “how seals and birds who swam in the water would be blinded and suffocated by contact with the oil.” This spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, although the event is still remembered more importantly as a time of devastation and deprivation by those who directly witnessed the effects of the spill or those who were told of the event by witnesses. Not only were whales absent for 4 years following the spill, but other resources were absent or occurred in reduced numbers. The people of Barrow who remember the spill

consider it evidence that even a relatively small oil spill in a defined area can have lasting effects on subsistence resources and harvests (Brower, as cited in NSB, Commission on History and Culture, 1980).

Caribou and Other Terrestrial Mammals. Small spills could have an additive effect on caribou, muskoxen, grizzly bears, and arctic foxes, perhaps increasing contamination of terrestrial habitats at facility sites and along pipelines by perhaps 1-2%. Some tundra vegetation in the pipeline corridor would become contaminated from these spills. However, because they are selective grazers and particular about the plants they consume, caribou and muskoxen probably would not ingest oiled vegetation (Kuropat and Bryant, 1980). If a pipeline spill occurred, it is likely that control and cleanup operations (ground vehicles, air traffic, and personnel) at the spill site would frighten caribou, muskoxen, grizzly bears, and arctic foxes away from the spill and prevent them from grazing on the oiled vegetation. Small spills would tend to be localized, although contamination effects could last several years; however, they are not likely to directly affect caribou, muskoxen, or other terrestrial mammals through ingestion of oiled vegetation. The extent of environmental impacts would depend upon the type and amount of materials spilled, the location of the spill, and effectiveness of the response (USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998a, 2001b, 2003a, 2004, 2006a,b,d).

Fish. Chronic small-volume crude and refined spills from all operations associated with production (25/year) typically would be 29-126 gal (0.7-3 bbl) in size. Depending on the launch area, spills of this size could dissipate before reaching important fish habitats; however, the large number of spills may result in spills reaching coastal areas, i.e., one spill per 2 years. The small-volume spill rate included spills from a future pipeline on land, and these spills could reach freshwater habitats used by fish. In the event of an onshore pipeline oil spill contacting a small waterbody supporting fish and having restricted water exchange, it likely would kill or harm most or all of the fish within the waterbody. If all of the fish in an isolated waterbody were killed, natural recovery would not occur. If habitats were restored and there was open exchange to other populated waterbodies, recovery would be likely in 5-10 years (USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998a, 2001b, 2003a, 2004, 2006a,b,d).

Subsistence-Food Contamination. Small oil spills have the potential to impact subsistence-harvest resources and patterns indirectly, because subsistence users will reduce their harvests of a particular resource if they fear that the resource has been contaminated. An oil spill of any volume into a river system or lake could have effects on subsistence-fish harvests. Loss of some portion of the subsistence-fish harvest would negatively affect the majority of communities in the proposed action area. Subsistence users typically would allow some period of time for contaminated resources or areas to recover following exposure to oil, effectively reducing the total resource amount and the total harvest area acreage available to them for the subsistence harvest (USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998a, 2001b, 2003a, 2004, 2006a,b,d).

4.4.1.12.1.4.3. Effects from Oil-Spill Response and Cleanup. Spill-cleanup strategies potentially would reduce the amount of spilled oil in the environment and tend to mitigate spill-contamination effects, especially in the case of a winter spill when few important subsistence resources would be present and cleanup is likely to be fairly effective. Ringed seals are common during the winter, but they are not commonly harvested by local subsistence hunters during this period. Disturbance to bowhead and beluga whales, seals, walrus, caribou, fish, birds, and polar bears would increase from oil-spill cleanup activities for spills occurring during breakup or the open-water season. Offshore, skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup could cause whales to temporarily alter their swimming direction. Such displacement would cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they are normally harvested or to become more wary and difficult to harvest. Cleanup disturbance would affect polar bears within about 1 mi of the activity.

People and boats offshore and people, support vehicles, and heavy equipment onshore, as well as the intentional hazing and capture of animals, would disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Deflection of resources, resulting from the combination of a large oil spill and spill-response activities, would persist beyond the timeframe of a single season, perhaps lasting several years. The result would be a major effect on subsistence harvests and subsistence users, who would suffer impacts on their nutritional and cultural well-being.

Subsistence hunting also would be impacted by any spill that required the local knowledge, experience, and vessels of local whaling captains. Diverting effort and equipment to oil-spill cleanup would adversely impact the subsistence whale hunt (and other harvesting activities). Far from providing mitigation, oil-spill-cleanup activities more likely should be viewed as an additional impact, potentially causing displacement of the subsistence hunt, subsistence resources, and subsistence hunters. The overall result would be a major effect on subsistence harvests and subsistence users, who would suffer impacts on their nutritional and cultural well-being. Impacts subsistence harvests and subsistence users would be significant if they persisted for more than a single harvest season (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM, 2004).

Bowhead Whales. There are no described observations concerning the level of disturbance on bowhead whales from cleanup activities, although the presence of offshore skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup are expected to cause whales to temporarily alter their swimming direction and cause temporarily displacement (USDO, MMS, 2002a, 2003a).

Beluga Whales and Other Marine Mammals. Ringed seals are common during the winter, but they are not harvested intensively by local subsistence hunters during this period. It is possible that cleanup operations could displace some ringed seals from maternity dens during the winter, resulting in the loss of a few seal and walrus pups. If a large oil spill occurred, contacted, and extensively oiled coastal habitats during the open-water season, the presence of cleanup personnel, boats, and aircraft operating in the cleanup area is expected to displace beluga whales, seals, and walrus and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring. These effects may occur during 1 or 2 years of cleanup; however, we do not expect it to greatly affect seal, walrus, and beluga whale behavior and movement beyond the area (within about 1 mi) of the activity or after cleanup (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM 2004).

Polar Bears. If a large oil spill occurred, contacted, and extensively oiled coastal habitats, the presence of cleanup personnel, boats, and aircraft operating in the cleanup area is expected to displace polar bears. It is possible that cleanup operations could displace some bears from maternity dens during the winter, resulting in the loss of a few bear cubs. These effects may occur during 1 or 2 years of cleanup; however, we do not expect it to greatly affect polar bear behavior and movement beyond the area (within about 1 mi of the activity) or after cleanup. Cleanup efforts should include the removal of all oiled animal carcasses to prevent polar bears from scavenging on them. Oil-spill-contingency measures that include the aircraft hazing of wildlife away from the oil spill could reduce the chances of polar bears entering coastal waters where there is an oil slick. However, such hazing may have to be repeated to be effective in preventing polar bears from entering the oiled water (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM, 2004).

Caribou and Other Terrestrial Mammals. If a large oil spill occurred, contacted, and extensively oiled coastal habitats containing herds or bands of caribou during the insect season, the presence of cleanup personnel, boats, and aircraft operating in the area of cleanup activities is expected to cause displacement of some caribou in the oiled areas and could seriously stress the herd, resulting in increased

mortality or decreased productivity. For most spills, control and cleanup operations at the spill site would frighten animals away from the spill and prevent them from grazing on oiled vegetation. For the most part, effects are likely to occur only during cleanup operations (1-2 seasons) and are not expected to significantly affect caribou herd movements or foraging activities. Cleaning up a large oil spill also would disturb some muskoxen, grizzly bears, and arctic foxes. An oil spill could result in the loss of small numbers of grizzly bears and arctic foxes through ingestion of contaminated prey or carrion. However, such losses are not expected to be significant to their populations on the Arctic Slope. A large onshore oil spill could disrupt subsistence-harvest activities for at least an entire season from oil-spill employment for oil-spill response and cleanup. If a large spill contacted and extensively oiled coastal habitat, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters (USDOI, BLM, 2006; USDOI, MMS, 2003a).

Fish. Because of the low density of fish in the region and the low probability that they would be harmed by cleanup equipment, oil-spill-cleanup activities in open water or in broken ice are not expected to adversely affect fish populations. Reducing the amount of oil in the marine environment is expected to have a beneficial effect by reducing the possibility of hydrocarbons contacting fish and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to not reducing the amount of contact (USDOI, MMS, 2003a).

Birds. The presence of large numbers of workers, boats, and aircraft following a spill is expected to displace eiders foraging in affected offshore or nearshore and coastal habitats during open-water periods for one to several seasons. Disturbance during the initial season, possibly lasting 6 months, is expected to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging birds. However, staging or migrating flocks of most species generally are dispersed and, thus, would not necessarily occur in the vicinity of cleanup activity; as a result, relatively few flocks are likely to be displaced from favored habitats and expend energy stores accumulated for migration. However, large flocks of long-tailed ducks molting in lagoons, and common eiders occupying barrier islands or lagoons are particularly susceptible if they are nesting, broodrearing, or flightless. Although little direct mortality from cleanup activity is expected, predators may take some eggs or young while females are displaced off their nests, if located near a site of operation. Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not expected to result in significant population losses (USDOI, MMS, 2003a).

4.4.1.12.1.5. Potential Effects from Seismic-Surveys. Noise and disturbance impacts would be associated with concurrent seismic surveys (both 2D and 3D) ongoing in the Beaufort and Chukchi seas during the open-water season. Potential seismic survey effects would occur primarily from vessel-based open-water seismic surveys in marine areas of the Chukchi and Beaufort seas. The primary effects could arise from airgun noise. Typical 3D-survey operations consist of a large seismic vessel that tows an airgun and receiving-cable arrays and a smaller support boat. Survey times average 20-30 days (with downtime) to cover an area of approximately 200 mi².

The coastal environment of the Beaufort and Chukchi seas contains important populations of whales, pinnipeds, fishes, and birds valued by subsistence hunters in the region. The animals commonly hunted by Inupiat Natives in local coastal communities are bowhead and beluga whales; walrus; bearded, ringed, and spotted seals; polar bears; anadromous and marine fishes; waterfowl; and seabirds. The species hunted by each village depend mainly on proximity of harvestable populations to each village and secondarily on harvest tradition. All of these biological resources and resource areas, to varying degrees, could be impacted by geophysical seismic-exploration activities. Vessel movements and traffic (seismic vessel, support vessels, ice-management vessel, etc.) and high-energy sound sources generated by the

seismic-airgun arrays adversely could affect subsistence resources and practices of Inupiat subsistence users if protective mitigation measures are not incorporated into seismic-operation plans. Potential effects from seismic noise and associated vessel movements could affect whaling, sealing, bird hunting, and fishing in the open-water season. Access to subsistence resources, subsistence hunting, and the use of subsistence resources also could be affected by reductions in subsistence resources and changes in the distribution patterns of subsistence resources (Becker, 1987; USDOl, MMS, 1987b, 1990b, 1995a, 2001a, 2003a, 2005b).

The greatest potential disruption from seismic-survey activities on the subsistence whale hunt would be expected during fall whaling in Kaktovik, Nuiqsut, and Barrow, if multiple seismic-survey operations deflect whales away from traditional hunting areas. Barrow's fall hunt would be particularly vulnerable. Noise effects from multiple seismic surveys to the west in the Chukchi Sea and to the east in the Beaufort Sea could cause migrating whales to deflect farther out to sea, forcing whalers to travel farther; thus, increasing the effort and danger of the hunt and increasing the likelihood of whale meat spoilage, as the whales would have to be towed from greater distances.

Barrow's fall hunt is particularly important, as it is the time when the Barrow whaling effort can "make up" for any whales not taken by other Chukchi and Beaufort whaling communities. These communities give their remaining whale strikes to Barrow, hoping that Barrow whaling crews will successfully harvest a whale and then share the meat back with the donating community. This practice puts a greater emphasis on the Barrow fall hunt.

Additionally, changing spring lead conditions—ice becoming thinner due to global climate change—has made the spring hunt more problematic and even as the fall hunt becomes more pivotal in the annual whale harvest for all communities in the region. Thus, any disruption of the Barrow bowhead whale harvest could have disruptive effects on regional subsistence resources and harvest practices (USDOl, MMS 1987a; Brower, 2005).

Conflict avoidance agreements (CAAs) between the AEWC and oil operators conducting one or perhaps two seismic operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities. However, the magnitude of concurrent seismic shoots has sorely tested the ability of oil operators and whalers to coordinate their efforts to prevent disruptions to the hunt using existing CAA protocols and other mechanisms for coordinating seismic-survey and whaling activities are presently being explored.

Effects from Seismic Surveys on Subsistence Resources.

Bowhead Whales. Bowhead whales can respond to noise and disturbance in a manner that would adversely affect the hunting of this species. Seismic surveys and associated vessels and helicopter traffic to and from the vessels have the potential to disturb these animals and displace them from normal migration patterns; such disturbance could disrupt the subsistence harvest. Generally, spring-lead whaling is done very quietly in man-powered skin boats. Gaining access to leads suitable for bowhead hunting dictates the success of Inupiat whale hunters, and this access can be hindered by double leads, young ice, changing weather conditions, and fairly recent changes in ice thickness and extent brought on by changing climatic conditions in the Arctic (Braund and Burnham, 1984; USDOl, MMS, 1987c).

If a seismic survey or support vessel were in the path of a whale chase, it could cause that particular harvest to be unsuccessful. Animals tend to avoid areas of high noise and disturbance and, thus, could become unavailable to a particular community or become more difficult to harvest. Many studies indicate that most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a

distance of a few kilometers but rarely show avoidance behavior at distances of more than 7.5 km (4.7 mi). Under these conditions, bowheads also exhibit tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Bowheads appear to recover from these behavioral changes within 30-60 minutes after seismic activity stops. However, recent monitoring studies (1996-1998) indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 km. The sighting rates of whales at a radius of 20 and 30 km was higher than the sighting rate within the 20-km radius, but it varied annually from no evidence of a reduced sighting rate in 1996 to a reduced sighting rate in 1998. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980s. Avoidance did not persist beyond 12 hours after the end of seismic operations. Short-term effects, such as flight behavior or increased wariness, also may make animals difficult to harvest.

Noise and traffic disturbance from transiting seismic-survey vessels, survey-related supply vessels, and support icebreakers in or near the bowhead whaling area could cause bowhead whales to move into the broken-ice zone and offshore leads inaccessible to the Inupiat hunters or under the pack ice and become unavailable to hunters. This displacement could have a major impact on local access and harvest success of bowhead whales. In plentiful ice years, the length of the whaling season still might allow a successful hunt; in a year when poor weather and ice conditions shortened the whaling season, such an occurrence could cause the harvest to be reduced. Because seismic-survey activity generally is not begun until after July 1 and conflict avoidance measures are expected to be in place, such conflicts during the spring whaling season are not expected (Braund and Burnham, 1984; USDOJ, MMS, 1987c 1990b, 1995a, 2003a, 2005b).

Beluga Whales. Beluga whales are sensitive to noise and may be displaced from traditional harvest areas by heavy boat traffic or seismic-survey noise. This disturbance response, even if brief, might temporarily interrupt the movements of belugas or temporarily displace some animals when the vessels pass through an area. Such events could interfere especially with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters. Additionally, there is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Inupiat hunter access. For example, Point Lay residents rely on the harvest of belugas more than any other Chukchi Sea village and, at the present time, they are very successful at herding these animals by boat into Kasegaluk Lagoon where they are then hunted. If noise from boat traffic and seismic-survey activity increased and the belugas acclimated to the noise, there is the possibility that this herding technique would be less successful and the hunt reduced (Braund and Burnham, 1984; USDOJ, MMS, 1987c 1995a, 1998a; Huntington and Mymrin, 1996; Huntington, 1999; Mymrin et al., 1999).

In other coastal communities, belugas are harvested in the pack-ice leads in the early summer. Because the beluga-hunting season for Kaktovik, Barrow, Wainwright, and Point Hope takes place under two different conditions (in ice leads and in open water) and hunting is possible at different times over a 6-month period (late March-September), noise and traffic disturbance would be expected to have lesser effects. However, repeated vessel passes close (within 1-4 km) to both hunters and cetaceans could disturb the whale hunt. At present, the beluga is not intensively hunted by Barrow, Nuiqsut, or Kaktovik (USDOJ, MMS, 1987a, 1990b, 1998a, 2003a).

Walrus. Impacts to walrus subsistence-harvest activities are most likely to occur during summer when the animals migrate from the Bering Sea into the Chukchi Sea. Walrus hunting is concentrated in each community's subsistence-resource area during the open-water months, primarily from late May and early June through the end of August. Peard Bay is preferred by Barrow and Wainwright residents to harvest walrus. Helicopter traffic and seismic-survey noise at this time could disturb walrus resting

on ice pans, although it is not expected to affect walrus migration or distribution patterns. The common method used to hunt walrus is to approach the herds as they rest on ice pans in the broken-ice margin of the pack ice. If increased seismic-survey noise caused the dispersal of these herds, hunting success of local residents could be detrimentally affected. Noise and disturbance from seismic-survey boats and other vessels could be a problem, if boat traffic moved near marine mammal-haulout areas. Because seismic-survey activities are unlikely to occur until after July 1 and must avoid areas with ice concentrations, conflicts with the subsistence walrus hunt are not expected. The walrus hunt is much more important to Chukchi Sea subsistence communities. It should be noted that the subsistence walrus hunt in Nuiqsut and Kaktovik in recent years has not been intensive but may be increasing due to walrus increasing their range eastward likely due to rapid changes in sea ice behavior. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on walrus (USDOI, MMS 1987a, 1990a, 1995a, 1998a, 2003a).

Seals. Effects of seismic-survey noise on seals are likely to have less adverse subsistence-use effects than is the case with whales. Such disturbance is not likely to have more than short-term effects on migrations or distributions; but the displacement of pinnipeds could affect the availability of these animals to subsistence hunters for that season. These short-term, localized effects on seals could negatively affect localized subsistence-hunting, but probably not affect overall annual harvest levels, and seals would not become unavailable during the year. Generally, the seal-harvest period is longer than for whales and allows residents to harvest seals during more times during the year. On the other hand, recent radical changes in sea-ice extent and behavior may have even greater impacts on the subsistence seal hunt. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on seals (USDOI, MMS, 1987c 1990b, 1995a, 1998a, 2003a).

Birds. Although MMS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. “Ramping up,” a gradual increase in decibel level as seismic activities begin, can allow diving birds to hear the startup of the seismic survey and help disperse them before harm occurs. During seismic surveys, diving birds likely would hear the advance of the slow-moving survey vessel and associated airgun operations and move away. It is possible that seismic surveys might affect fish and invertebrates in proximity to the airgun array; however, the effects of seismic surveys on marine fish that might change their availability to marine birds have not been documented under field-operating conditions. If forage fishes are displaced by airgun noise, birds feeding on those resources might be displaced temporarily and stop feeding within a few kilometers of the survey activities.

The impacts of noise and disturbance in offshore areas on waterfowl could disturb waterfowl feeding and nesting activities, but effects are expected to be periodic and short term and not to have significant effects on bird harvesting by coastal subsistence communities. Seismic-survey activities are not anticipated to occur in nearshore waters where many marine birds are found and where subsistence harvesting occurs. Seismic-survey vessels would remain at least 17 km (10 mi) offshore, so they would not come close to bird-nesting areas. It is more likely that vessels might disturb marine and coastal birds that are foraging, resting or molting at sea (Braund and Burnham, 1984; USDOI, MMS, 1987c 1990b, 1995a, 1998a).

Fish. The impacts of noise and disturbance in offshore areas on fish harvests likely would be minimal, although the increased noise potential of multiple concurrent seismic surveys (especially ocean-bottom-cable surveys in shallower waters nearshore) could displace and disturb fish migrations and distributions and potentially “herd” them away from traditional subsistence-fishing areas (Braund and Burnham, 1984; USDOI, MMS, 1987c 1990b, 1995a).

Polar Bears. Active seismic-survey activities are likely to result in startle responses by polar bears near the sound source. As with other vessel traffic, this disturbance response is likely to be brief, and affected animals are likely to return to normal behavior patterns within a short period of time after seismic vessels have left the area. Because seismic-survey activities are not planned until after July 1 and would avoid areas of high ice concentration, conflicts with the subsistence polar bear hunt are not expected. Recent radical changes in sea-ice extent and behavior and its effect on polar bear behavior and survival and the resulting listing of the species as threatened by the FWS may have far greater impacts on the subsistence polar bear hunt than seismic-survey disturbance. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on polar bears (USDOJ, MMS 1987c 1998a, 2003a).

4.4.1.12.1.6. Potential Effects from Habitat Loss. Habitat loss occurs as facilities are developed, covering tundra habitats used by terrestrial subsistence species. Hundreds of acres of North Slope habitat have been occupied by oil and gas infrastructure, such as pads, pipelines, roads, gravel pits, etc., as well as community development (residences, schools, airports, roads, landfills, etc.). Secondary impacts occur from altered hydrology associated with these facilities, flooding some areas and drying others. While some species may have or would benefit from wetter or drier habitats near these facilities, evidence suggests that many species avoid using habitats near these developments and the human activities they support. For example, regular vehicle traffic on roads could result in the permanent displacement of nesting birds in a zone of influence around a particular development.

The gradual and continual loss of habitat associated with oil and gas development on the North Slope has been documented in a number of studies (Walker et al., 1986, 1987; Walker and Walker, 1991). Walker et al. (1987), in a geobotanical mapping study, concluded that by 1986 the Prudhoe Bay oil field occupied about 500 km² between the Kuparuk and Sagavanirktok Rivers that included 359 km of roads, 21 km² of tundra covered by gravel, and 14 km² that had been flooded by road and gravel-pad construction. Growth since 1968 had proceeded at a constant rate, and it was noted that construction at the Kuparuk Field was proceeding at a similar rate, thus doubling the total rate of development. Walker et al. (1987) considered these to be major landscape impacts and recommended that the implications to wetland values, wildlife corridors, and caribou calving grounds be addressed. It was suggested that such studies (which are necessary for assessing cumulative impacts in the region) would be hampered by the lack of baseline information at Prudhoe Bay prior to development. Nevertheless, methods needed to be developed to assess cumulative impacts so as to foster better comprehensive regional planning on Alaska's arctic coastal plain (ACP). Although recent innovations in the oil industry have reduced the size of an oil field "footprint" (Robertson, 1989), habitat loss must continually be assessed and such information used to keep track of cumulative effects to wildlife populations, subsistence resources, and subsistence harvests.

In 2003, development had directly covered about 7,000 acres through the construction of 350 mi of roads, 90 pads, and 14 gravel mines. Gravel mines cover more than 1,500 acres. Development in the Prudhoe Bay and Kuparuk areas has directly affected about 9,500 acres because of gravel excavation and filling, and indirectly affects many adjacent acres of vegetation. The total affected acreage is a small part of the ACP, and cumulative effects probably are not significant to the overall productivity of tundra plants in this area. It is important to remember that ongoing oil development projects, such as Alpine, Badami, and Northstar, have required a much smaller acreage footprint than existing and past projects on the North Slope. The effect of future onshore facilities siting (dust fallout, thermokarst, and hydrologic change) on many species is expected to be less severe, because effects would be restricted to much smaller areas and result in less habitat loss. Pads, gravel quarries, pipelines, pump stations, and gravel roads that cross much of the Central Arctic caribou herd's calving range actually have destroyed only about 3-4% of the tundra grazing habitat for caribou. Rapid habitat changes due to global climate change would serve to exacerbate anticipated habitat loss and habitat impacts.

An increase in abundance of deciduous shrubs (less favorable caribou forage), especially birch, and a decline in the abundance of grasses/sedges such as *Eriophorum vaginatum* (an especially important food of calving caribou) would be predicted if a significant increase in average temperature were to occur in the Arctic, effect that could reduce the productivity of caribou habitats on the Arctic Slope (Anderson and Weller, 1996). Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals and some bird species, thereby adversely affecting their populations (Anderson and Weller, 1996).

Alterations from offshore production platform-island construction, trench dredging, and pipeline burial would affect some benthic organisms and some fish species within 1 km for <1 year or season. These activities also temporarily would affect the availability of some local food sources for these species up to 1-3 km (0.62-1.9 mi) distance during island construction, but these activities would not be expected to affect food availability for seals over the long term.

4.4.1.12.1.7. Potential Effects from Onshore Development.

General Effects to Subsistence. At an MMS Information Update Meeting held March 29, 2000, in Barrow, the ADF&G made a presentation on a draft study of subsistence economics and oil development in Nuiqsut and Kaktovik, which affirmed a strong connection to anthropogenic effects as the cause for the displacement of subsistence hunters from traditional caribou-hunting areas near Nuiqsut during the 1993 and 1994 harvest seasons (Pedersen et al., 2000).

Industrialization clearly displaces subsistence users from traditional use areas, even if no legal impediments to access are imposed (NSB, 2003). Therefore, if development occurred in areas containing concentrations of subsistence cabins, camps, and traditional use sites and subsistence resources experienced only minor impacts, subsistence users would be displaced and impacts would be expected to be far greater. The BLM expects its subsistence stipulations to mitigate potential exploration and development conflicts with subsistence cabins, camps, and use sites (USDOJ, BLM and MMS, 2003).

4.4.1.12.1.8. Potential Effects from Production Activity. Other than the pending Liberty development and the existing Northstar development, production of oil or gas from existing leases in the Chukchi and Beaufort seas is speculative. Oil or gas production includes activities that could result in increased disturbance and displacement of subsistence resources and subsistence practices.

The primary sources of disturbance and/or displacement include: (1) vessel and aircraft presence and noise; (2) airgun noise associated with seismic surveys; (3) facility placement, operation, and maintenance in offshore areas; (4) pipeline trenching and construction; (5) off- and onshore pipeline placement, maintenance, and operation; (6) pipeline maintenance roads; (7) other facilities (such as onshore landfalls and processing facilities) located in subsistence-resource habitat or key subsistence-harvest areas; and (8) impacts associated with large oil spills.

Overall, potential disturbance effects from production operations may be more difficult to mitigate, as such activities will by definition be longer term and operate year-round. The need to install up to 4-13 production platforms, drill 160-400 production wells, construct 90-550 mi of offshore pipeline, up to 500 mi of onshore pipeline, and construct 3 pipeline landfalls and 2 new shorebases in the region could increase the areas and times where subsistence resources and activities are restricted. This would increase the possibility for significant harvest disruption. This would be further exacerbated if construction and production activities were concentrated in critical subsistence-use areas rather than dispersed. Offshore pipeline effects on subsistence generally will be confined to the period of construction and will be

mitigated through lease stipulations, which will minimize industry activities during critical subsistence-use periods.

The major onshore pipeline constructed for the proposed action would connect Chukchi Sea oil and gas production with the TAPS. It would cross a large area that is undeveloped, except for isolated and relatively small airstrips in various conditions. The potential impact of the pipeline on subsistence-resource-use patterns, while unavoidable, can be at least partially mitigated and minimized with proper pipeline design and location/routing. Potential effects of a pipeline on subsistence users (perceptions of areas they wish to avoid or are difficult for them to access for hunting) can be addressed with design considerations (for instance, by elevating or burying segments of the pipeline) and by including subsistence users in the consultation process. The most difficult potential onshore pipeline effects to mitigate would be those related to pipeline servicing and access. If a service road is constructed for this purpose, it would greatly increase impacts to caribou movement and access to subsistence resources on the western part of the North Slope. This effect would be greater if such a road were eventually opened to public access, on the model of the Dalton Highway. Roads also are reported to impose substantial maintenance costs on subsistence equipment (snow machines and sleds) and to present some safety issues (Impact Assessment, Inc., 1990a). Current practices are to minimize the construction of new roads. If pipeline servicing was conducted using aircraft, and perhaps ice roads or other ground transport in winter, such potential access effects would be minimized. Increased aircraft traffic in the summer could have a moderate effect on subsistence uses, but with coordination with subsistence users such impacts could be reduced.

Negative impacts to caribou can be minimized by mitigation measures, including: (1) construction of pipelines at least 100 m from roads; (2) elevation of the pipelines above the ground to ensure that caribou can pass underneath; (3) maintenance of traffic control in critical areas such as calving grounds, in season; (4) installation of buried or higher than normal pipelines in areas that are typically traveled heavily by caribou; and (5) adherence to minimum altitude levels for service aircraft in flight.

4.4.1.12.1.9. Potential Effects from Climate Change. Past and ongoing changes to the Arctic environment due to climate change are discussed in Section 3.4.2.7, Arctic Climate Change. In the Arctic, a factor of increasing concern is the potential for adverse effects on subsistence-harvest patterns and subsistence resources from habitat and resource alterations due to the effects of global climate change. The Council on Environmental Quality (CEQ) provides guidance on National Environmental Policy Act (NEPA) regulations and its mandate to consider all “reasonably foreseeable” environmental impacts of a proposed Federal action in a NEPA assessment. Based on current scientific evidence (e.g., the Second Assessment Report by the Intergovernmental Panel on Climate Change [IPCC]), the CEQ considers that there is adequate scientific evidence indicating that climate change is a “reasonably foreseeable” impact of greenhouse gas emissions (CEQ, 1997; IPCC, 2001a,b).

Permafrost thawing is expected to continue to damage roads and buildings and contribute to eroding coastlines and increase building and maintenance costs in the Arctic. Shifting buildings, broken sewer lines, buckled roads, and damaged bridges already have caused \$35 million worth of damage annually in Alaska. In Kotzebue, the local hospital had to be relocated because it was sinking into the ground (ARCUS, 1997). Sea-level rise and flooding threaten buildings, roads, and power lines along low coastlines in the Arctic and, combined with thawing permafrost, can cause serious erosion. Kaktovik’s 50-year-old airstrip has begun to flood because of higher seas, and may need to be moved inland (Kristof, 2003). Shore erosion in Shishmaref, Kivalina, Point Hope, Wainwright, and Barrow in Alaska and Tuktoyaktuk at the mouth of the MacKenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline.

The duration of ice-road usefulness in the Arctic already has diminished by weeks and has led to an increased need for more permanent gravel roads. However, gravel roads are more prone to the effects of permafrost degradation, thermoclast, and consequent settling that increases maintenance costs (Nelson, 2003c). Gravel roads also contribute to the fragmentation of landscapes and habitats that can lead, through time, to reduced species' productivity and availability.

Continuing sea-ice melting and permafrost thawing could threaten subsistence livelihoods. Typically, peoples of the Arctic have settled in particular locations because of their proximity to important subsistence-food resources and dependable sources of water, shelter, and fuel. Northern peoples and subsistence practices will be stressed to the extent that these following observed changes continue:

- settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise;
- traditional hunting locations are altered;
- subsistence travel and access difficulties increase; and
- game patterns shift and their seasonal availability changes.

Large changes or displacements of resources are likely, leaving little option for subsistence communities: they must quickly adapt or move (Langdon, 1995; Callaway, 1995; *NewScientist*, 2002; Parson et al., 2001; AMAP, 1997; *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001a). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird-breeding and -molting areas, affect the distribution and abundance of anadromous and freshwater fish, and limit or alter subsistence access routes, particularly in spring and fall (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal-migration routes and this, in turn, could impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001).

4.4.1.12.2. Mitigation Measures.

Three NTLs proposed in this EIS (see Section 2.2 and Appendix F) would mitigate potential impacts to subsistence-harvest patterns.

NTL No. 08-A02 Protection of Subsistence Whaling and Other Marine Mammal

Subsistence-Harvest Activities provides guidance to the lease owner/operator related to protection of subsistence-harvest of whales and other marine mammals during the conduct of any operations on a lease. It is issued to clarify and interpret the requirements contained in regulations for protection of subsistence activities. The MMS operating regulations at 30 CFR 250.202 state that proposed activities shall be conducted in a manner that does not unreasonably interfere with other uses of the OCS and does not cause undue of serious harm to the human environment. Exploration, development, production, and support activities shall be conducted in a manner that prevents reasonably foreseeable conflicts between the lease owner/operator activities and subsistence activities (including, but not limited to, bowhead whale and other marine mammal subsistence hunting). If proposed activities have the potential to adversely affect subsistence harvest activities, MMS will require Exploration Plans or Development and Production Plans to include an Adaptive Management and Mitigation Plan (AMMP). This NTL encourages lessees to meet with local communities and subsistence groups to resolve potential conflicts.

NTL No. 08-A03 Industry Site-Specific Marine Mammal Monitoring Programs provides guidance to the lease owner/operator related to monitoring of marine mammals during the conduct of any operations on a lease. The MMS final rule published in the *Federal Register* on April 13, 2007 (Volume 72, Number 71, pages 18577-18585) requires OCS lease owners/operators to provide information on how

they will conduct their proposed activities in a manner consistent with the provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The final rule identifies environmental, monitoring, and mitigation information that must be submitted with Exploration Plans (EPs) and Development and Production Plans (DPPs). The final rule requires lease owners/operators to describe how they will mitigate the potential for takes to occur, monitor for potential takes, and report takes should they occur. The MMS operating regulations at 30 CFR 250.221(b) and 30 CFR 250.223 are requirements for EPs to include descriptions of monitoring and mitigation measures to address federally listed species and marine mammals if there is reason to believe the exploration activities may result in an incidental take. The MMS operating regulations at 30 CFR 250.252(b) and 30 CFR 250.254 are requirements for DPPs to include descriptions of monitoring and mitigation measures to address federally listed species and marine mammals if there is reason to believe the development and production activities may result in an incidental take. The NTL clarifies and interprets the requirements contained in regulations.

NTL No. 08-A04 Marine Mammal Protection Act Authorizations provides guidance to the lease owner/operator related to the need for obtaining authorization from the National Marine Fisheries Service (NMFS) and/ or the U.S. Fish and Wildlife Service (FWS) pursuant to the MMPA. It is issued to clarify and interpret the requirements contained in regulations for conduct of activities in a manner consistent with the provisions of the MMPA. The MMS will not authorize activities that it believes may result in an unauthorized, and therefore illegal, incidental take.

Mitigation Specific to Seismic Surveying. The following section discusses mechanisms for protecting subsistence-harvest activities from the possible impacts associated with seismic surveys. An operator could propose to conduct seismic-survey activity in an area critical to whaling during the whaling season; however, if this condition did occur, potential conflict could be mitigated by the cessation of activities during the whale migration. Theoretically, the larger the exclusion zone coupled with shut-down procedures, the greater protection of marine mammals from potential harassment and injury; thus, a 120-dB isopleth-safety zone would afford more protection from harassment and injury for marine mammals than a 180/190-dB isopleth-exclusion zone. The more marine mammals are protected, the more subsistence-harvest activities are protected. A current concern by local whalers is that increased industrial noise levels in the Beaufort and Chukchi seas will force hunters to travel farther to find whales, and that this may lead to reduced success and an increased struck and lost rate for hunters that, in turn, may cause the IWC to reduce the bowhead whale quota.

Because fall ice conditions are not predictable events, user conflicts between vessels and whalers due to bad ice conditions could produce a situation difficult to mitigate. This problem has been reported once for the Alaskan Arctic. In fall 1985, extreme ice conditions curtailed the length of Kaktovik's whaling season and, at the same time, caused vessels traveling to their overwintering sites to operate near whaling locations (Smythe, 1987, pers. commun., as cited in USDO, MMS, 1990a).

As a result of this conflict, a cooperative program was formed in 1986 between the NSB, the AEW, the Nuiqsut and Kaktovik whaling captains, and those petroleum companies interested in conducting geophysical studies and activities in the Beaufort Sea. This program was approved through a Memorandum of Understanding between NOAA and the AEW pursuant to the 1983 Cooperative Agreement, as amended. The 1986 Oil/Whalers Working Group established a communication system and guidelines to ensure that industry vessels avoided interfering with or restricting the bowhead whale hunt and to establish criteria whereby the oil industry would provide certain kinds of assistance to the whalers. The program was successful for 2 years; however, it has been discontinued due to some difficulties with the communication systems and equipment. The Oil/Whalers Working Group cooperative program was a good example of how interference with a subsistence harvest can be effectively mitigated. In the absence

of such mitigation, such a curtailment of the whale-harvest season due to noise could cause bowhead whales to become locally unavailable for the harvests in Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope (USDOI, MMS, 1990b).

The MMS, along with industry, their contractors, scientists, the NSB Mayor's Office, the NSB Wildlife Management Department, and the AEW, participate in the NMFS annual Peer Review Workshop to address monitoring issues as they relate to the NMFS administration of its responsibilities for ESA and IHA processes under the MMPA. Workshop participants review the results of monitoring efforts to determine the impacts of industry activities on marine mammals in the Beaufort and Chukchi seas and review monitoring plans for the upcoming field season. Required mitigation defined in an AMMP and an IHA would specify any noise-monitoring program for marine mammals required for ongoing seismic operations in the Chukchi and Beaufort seas and would be considered through the Peer Review Workshop meetings. Any potential monitoring program would be designed to: (1) assess when bowhead and beluga whales, walrus, and bearded seals are present in the vicinity of potential operations and the extent of behavioral effects on these species due to operations; (2) consider the potential scope and extent of impacts that the particular type of operation could have on these species; and (3) address local subsistence hunters' concerns and integrate Inupiat traditional knowledge (USDOI, MMS, 2003a).

Other coordination meetings concerning noise impacts included the Arctic Seismic Synthesis Workshop in Barrow in 1997, hosted by MMS that brought together Native whalers, the oil industry, and acoustic scientists to discuss the issue of the distance at which bowheads are deflected from their normal migration path by seismic noise. Whaling captains collectively presented information on distances at which bowhead whales reacted to seismic vessels. Other concerns raised by local subsistence hunters that pertain to potential seismic-noise impacts include: (1) developing a plan for minimizing the number of sealifts and making sure they are completed before the fall subsistence whaling season begins; and (2) developing a plan that ensures that local/Native observers are present during seismic activity to monitor for potential noise disturbance to marine mammals (USDOI, MMS, 2003a). Because the permittees normally seeking a LOA or IHA for incidental take from NMFS, the monitoring program and review process required under the LOA or IHA generally can satisfy the monitoring requirements of Stipulation 5's required AMMP.

Through consultation, the seismic-survey operator would make every reasonable effort to ensure that exploration activities are compatible with whaling and other subsistence-hunting activities and will not result in unreasonable interference with subsistence harvests. A discussion of resolutions reached during this consultation process and plans for continued consultation will be included in the exploration plan or permit. In particular, the permittee will show in the AMMP how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities.

The seismic-survey operator also would include a discussion of multiple or simultaneous operations, such as drilling and ancillary activities, that can be expected to occur during operations to more accurately assess the potential for any cumulative effects. Communities, individuals, and other entities who were involved in the consultation will be identified in the AMMP plan. The MMS shall send a copy of the plan to the directly affected communities, the AEW, the ABWC, the EWC, the ISC, and the NC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process. In the event no agreement is reached between the parties, the permittee, the AEW, the ABWC, the EWC, the ISC, the NC, the NSB, and NMFS, or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO to assemble a group consisting of representatives from the subsistence communities, the AEW, the ABWC, the EWC, the ISC, the NC, the NSB, NMFS, and the permittee(s) to specifically address the conflict and attempt to resolve the issues before the RS/FO makes a final determination on the adequacy of the measures taken to prevent

unreasonable conflicts with subsistence harvests. Permittee-related use will be restricted when MMS determines it is necessary to prevent unreasonable conflicts with local subsistence-hunting activities. In enforcing this stipulation, MMS will work with other agencies and the public to ensure that potential conflicts are identified and efforts are taken to avoid these conflicts.

For MMS-permitted seismic surveys, NMFS- and FWS-sanctioned observers, usually local Alaskan Natives and biologists employed by the monitoring contractor, are onboard survey vessels. These observers stop seismic operations when they observe marine mammals within the safety radius designated by NMFS. Shut down of the airguns occurs if marine mammals are within this radius because of concern about possible effects on marine mammal hearing sensitivity (USDOJ, MMS, 2003a).

Seismic surveys for geophysical exploration activities in the Beaufort and Chukchi Seas would be permitted with existing Alaska OCS exploration stipulations and guidelines and incorporate standard G&G-permit stipulations to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. An inability to effectively perform mitigation measures would result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated. The standard stipulations for MMS-permitted seismic survey activities and specific measures for mitigating seismic-survey impacts on subsistence resources and practices are provided in Appendix K.

Collectively, the above mitigation mechanisms would help protect subsistence-harvest activities from the possible impacts associated with seismic surveys. An operator could propose to conduct seismic-survey activity in an area critical to whaling during the whaling season; however, if this condition did occur, potential conflict could be mitigated by the cessation of activities during the whale migration. Theoretically, the larger the exclusion zone coupled with shut-down procedures, the greater protection of marine mammals from potential harassment and injury. The more marine mammals are protected, the more subsistence-harvest activities are protected.

State of Alaska Mitigation. Mitigation measures for existing and anticipated Beaufort Sea lease sales on State of Alaska lands specific to protection of subsistence resources and harvest include an orientation training stipulation (similar to MMS Lease Stipulation 1, Section 2.2.3.1) and provisions for subsistence-harvest protection (ADNR 2008 at http://www.dog.dnr.state.ak.us/oil/products/publications/beaufortsea/bsa1999_final_finding/bsfinding_contents_pdf.htm):

Training.

13. The lessee must include in any plan of exploration or plan of development a training program for all personnel, including contractors and subcontractors, involved in any activity. The program must be designed to inform each person working on the project of environmental, social, and cultural concerns that relate to the individual's job.

The program must employ effective methods to ensure that personnel understand and use techniques necessary to preserve geological, archeological, and biological resources. In addition, the program also must be designed to help personnel increase their sensitivity and understanding of community values, customs, and lifestyles in areas where they will be operating. The program must include an explanation of the applicable laws protecting cultural and historic resources. The program shall address the importance of not disturbing archeological, cultural, and historic resources and provide guidance on how to avoid disturbance.

Subsistence-Harvest Protection.

15a. Exploration, development or production operations shall be conducted in a manner that prevents *unreasonable conflicts* between lease related activities and subsistence activities. In enforcing this mitigation measure, the division, during review of plans of operation, will work with other agencies and the public to assure that potential conflicts are identified and avoided to the fullest extent possible. Available options include alternative site selection, requiring directional drilling, seismic and threshold depth restrictions, subsea completion techniques, seasonal drilling restrictions, and the use of other technologies deemed appropriate by the Director.

15b. Prior to submitting a plan of operations for both onshore and offshore activities that have the potential to disrupt subsistence activities, the lessee shall consult with the potentially affected subsistence communities, the AEW and the NSB (collectively “parties”) to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. The parties shall also discuss the reasonably foreseeable effects on subsistence activities of any other operations in the area that they know will occur during the lessee’s proposed operations. Through this consultation, the lessee shall make reasonable efforts to assure that exploration, development, and production activities are compatible with subsistence hunting and fishing activities and will not result in unreasonable interference with subsistence harvests.

15c. A discussion of resolutions reached or not reached during the consultation process and plans for continued consultation shall be included in the plan of operations. The lessee shall identify who participated in the consultation and send copies of the plan to participating communities and the NSB when it is submitted to the division.

15d. If the parties cannot agree, then any of them may request the Commissioner of ADNR or his designee to assemble the parties. The commissioner may assemble the parties or take other measures to resolve conflicts among the parties.

15e. The lessee shall notify the director of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns.

15f. Lease-related use will be restricted when the Director determines it is necessary to prevent unreasonable conflicts with subsistence harvests.

Whale Harvest Protection.

16a. Permanent facility siting on Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the NSB, in consultation with the AEW, that the development will not preclude reasonable access to whales as defined in NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement, if required by the NSB. With the approval of the NSB, the director may authorize permanent facilities.

16b. Permanent facility siting in State waters within 3 miles of Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the director, in consultation with the NSB and the AEW, that the development will not preclude reasonable access to whales as defined in NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement if required by the NSB.

16c. Permanent facility siting in State waters between the west end of Arey Island and the east end of Barter Island (Tracts 40 through 45) will be prohibited unless the lessee demonstrates to the satisfaction of the director, in consultation with the NSB and the AEW, that the development will not preclude reasonable access to whales as defined in NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement if required by the NSB.

Drilling.

17. Any tract or portion thereof in the Beaufort Sea areawide sale area may be subject to the March 1990 Beaufort Sea Seasonal Drilling Policy in conjunction with the submission of a plan of operations permit application by the lessee. This measure will be reevaluated and updated periodically on the basis of experience and new information.

17a. Exploratory Drilling From Bottom-founded Drilling Structures and Natural and Gravel Islands. Subject to condition c below, exploratory drilling operations and other downhole operations from bottom-founded drilling structures and natural and gravel islands are allowed year-round in the Central Subsistence Whaling Zone (SWZ) (Subsistence Whaling Zones: Eastern SWZ is that area within 20 nautical miles of the shoreline between 141° and 144° W longitude; Central SWZ is that area within 20 nautical miles of the shoreline between 144° and 151° W longitude; Western SWZ is that area within 20 nautical miles of the shoreline between 154° and 157° W longitude.) In the Eastern SWZ, drilling is prohibited upon commencement of the fall bowhead whale migration until whaling quotas have been met.

17b. Exploratory Drilling Operations from Floating Drilling Structures. Subject to condition c, exploratory drilling below a predetermined threshold depth and other downhole operations from floating drilling structures is prohibited throughout the Beaufort Sea upon commencement of the fall bowhead whale migration until the whale migration mid point. (Migration Dates: Eastern SWZ - September 1 - October 10 with the midpoint of the migration on September 20; Central SWZ and Western SWZ - September 10 - October 20 with the midpoint of the migration on September 28; Outside SWZ - Seaward of the Eastern SWZ - September 1 - October 10 with the midpoint of the migration on September 20; Seaward and west of the Central SWZ - September 10 - October 20 with the midpoint of migration on September 28. The midpoint of the migration is when 50 percent of the whales have been deemed to have passed the drill site.)

In addition to the above restriction, exploratory drilling above and below a predetermined threshold depth in the Eastern SWZ from floating drilling structures is prohibited upon commencement of the fall bowhead whale migration until the whaling quotas have been met.

In the Central and Western SWZ, exploratory drilling above and below a predetermined threshold depth may be prohibited on a case-by-case basis until the whaling quotas have been met. (If upon review of the proposed operation using the above described criteria, the State determines that conflict with subsistence whaling activities may occur, additional drilling restrictions, similar to those imposed for the Eastern SWZ, may be imposed in the Central and Western SWZs. In the Eastern SWZ, drilling is prohibited upon commencement of the fall bowhead migration until whaling quotas have been met.) The following criteria will be used to evaluate these operations: (1) proximity of drilling operations to active or whaling areas; (2) drilling operation type and feasible drilling alternatives; (3) number of drilling operations in the same area, (4) number of whaling crews in the area; and (5) the operator's plans to coordinate activities with the whaling crews in accordance with the subsistence harvest protection mitigation measure.

All nonessential activities associated with drilling are prohibited in the Central SWZ during the whale migration, until whaling quotas have been met. Essential support activity associated with drilling structures occurring within active whaling areas shall be coordinated with local whaling crews in accordance with the subsistence harvest protection mitigation measure.

“Essential activities” include those necessary to maintain well control, maintain physical integrity of the drilling structure, and scheduled crew changes. Support craft include aircraft, boats, and barges. “Nonessential activity,” by exclusion, are those activities that do not fit the definition of essential activities. Both types of activities must be described by the operators in their exploration plans submitted for State review. To the extent feasible, mobilization or demobilization of the drilling structures should not occur during the whale migration. If operators propose to mobilize or demobilize during the whale migration, they must describe the activity in their exploration plan and must demonstrate why the activity must occur during the migration period.

17c. Exploratory Drilling in Broken Ice. Consistent with the May 15, 1984, “Tier 2” decision, lessees conducting drilling operations during periods of broken ice must:

- (1) participate in an oil-spill-research program;
- (2) be trained and qualified in accordance with Minerals Management Service standards pertaining to well-control equipment and techniques; and
- (3) have an oil-spill-contingency plan approved by the State that meets the requirements of the “Tier 2” decision, including requirements for in situ igniters, fire-resistant boom, relief-well plans, and decision process for igniting an uncontrolled release of oil.

Public Access.

18. No restriction of public access to, or use of, the lease area will be permitted as a consequence of oil and gas activities except in the immediate vicinity of drill sites, buildings and other related facilities. Areas of restricted access must be identified and a rationale justifying the area restriction must be included in the plan of operations.

Specific Measures.

Seals. To protect hauled-out spotted seals, boat and barge traffic will be prohibited between July 15 and October 1 within one-half mile of the Piasuk River delta and Oarlock Island.

Collectively, the above MMS and State of Alaska mitigation would help protect subsistence resources and harvest activities from potential impacts associated with vessel and aircraft disturbance, oil spills, seismic surveys, and production activities, as described above.

4.4.1.12.3. Traditional Knowledge on Effects from Vessel and Aircraft Disturbance, Discharges, Large Oil Spills and Cleanup, Small Oil Spills, Seismic Surveys, Other Sources, and Climate Change.

4.4.1.12.3.1. Traditional Knowledge on Effects from Noise and Disturbance.

Aircraft and Vessel Support.

Bowhead Whales. Many Inupiat whale hunters express a traditional belief that whales can detect sounds much farther than can be measured by scientific instruments. This traditional belief implies that whales can perceive sounds and changes in the environment that cannot be detected by hearing, as

hearing is defined by science. By traditional terms, whales also may be able to “hear” electromagnetic waves from radio broadcasts, hear sounds in the water or in the air for hundreds of miles, and understand what people are saying about them anywhere in the whale’s yearly movements and react accordingly. The end result is that the whales may decide to either make or not make themselves available to hunters based on the sounds they hear or how people behave toward them. This premise is applied to other animal species as well (Burch, 1999). Traditional knowledge about the spiritual ability of whales to “hear” varies from place to place and from person to person (U.S. Army Corps of Engineers, 2005).

During spring whaling, pilots flying in and out of Barrow are asked not to fly planes over ice leads, no outboards are used unless they are towing a whale, and no duck hunting takes place in or near whaling camps or from whaling boats. Hunters in the Barrow and Point Hope areas keep dogs, snowmachines, and camps behind ice ridges so the noise will not be heard in leads where whales may move. Hunters in Kivalina chartered planes to search for open leads, but the planes land long before the hunters arrive at the leads to hunt. The whaling camp in the Point Hope area was kept clean, and smelly things were kept to the north of the hunters, because the whales migrated from the south. If hunters had to urinate or defecate, they would do it on the ice to the north of the boat so the whale would not smell the unpleasant odors and avoid them. At Barrow, burning is not permitted at the dump (Lowenstein, 1981; Burch, 1985; George, 1996; U.S. Army Corps of Engineers, 2005).

According to the late Burton Rexford, former chairman of the AEWG: “Loud noises drive the animals away.... We know where whales can be found; when the oil industry comes into the area, the whales aren’t there. It is *not* the ice; it is the noise” (NMFS, 1993b; USDO, MMS, 1998a).

The late Barrow elder, Thomas P. Brower, Sr., began whaling in 1917 as a boy. He stated in a 1978 interview that:

The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In the fall, we have to go as much as 65 miles out to sea to look for whales. I have adapted my boat’s motor to have the absolute minimum amount of noise, but I still observe that whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration, the bowheads travel in pods of 60 to 120 whales. When they hear the sound of the motor, the whales scatter in groups of 8 to 10, and they scatter in every direction (NSB, Commission on History and Culture, 1980; USDO, MMS, 2003a).

One of the most serious concerns to North Slope Inupiat is that potential increases in noise from oil development could disrupt normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. Eugene Brower, president of the Barrow Whaling Captains’ Association, articulated the issue in a statement he made at the January 6, 2000, meeting of the MMS Regional Offshore Advisory Committee:

I have the responsibility of talking on behalf of my whaling captains in Barrow. There’s 44 captains with 550 plus crew members that have great concern for the lease sales...the area of concern that we’re talking about is the whole migration route of the bowhead whale. What goes on in the eastern portion of the Canadian Border all the way through Barrow impacts three villages. [For] their livelihood, we have great concern.... The concern is always the same... but what impacts Kaktovik impacts Barrow and Nuiqsut in the middle. Anything that goes [on] in the east impacts us all the way to Barrow. And I, for one, would never want to see permanent structures out in the open sea because of the experience we had from...one little platform off

Cooper Island, five miles offshore. It was stationary, just idling. Just the noise being emitted from that structure was enough to divert the bowhead whales further out. There was nothing in between them, but nothing went through. It was always on the outside. So if you're going to be putting permanent facilities out in the water on the Beaufort, it's going to be making a lot of noise with the gravel pad, whatever structure you put out there. It's going to impact our livelihood. (USDOJ, MMS, 2001b)

Expressing concern about aircraft disturbance, a Nuiqsut resident and whaling captain said in testimony for an offshore lease sale that seismic traffic and helicopter overflights “were the cause of whales migrating farther north out to the ocean, 20 mi farther north than their usual migration route” (USDOJ, MMS, 1995b).

Patsy Tukle from Nuiqsut also expressed this sentiment. He explained that helicopters and ships are interfering with whale hunting, even though they are not supposed to. He affirmed the need to enforce controls so whaling may go on unimpeded (Tukle, 1986, as cited in USDOJ, MMS, 1986a; USDOJ, MMS, 2003a).

To show that aircraft disturb bowhead whales, Kaktovik resident Susie Akootchook related her observations while counting whales in Barrow:

I worked with the whale census and worked with Chris Clark that time they did the whale census over at Barrow. And I was with the acoustic crew listening in with speakerphones and those microphones were like a 100, 75 to 50 feet under. And if you guys are planning on using your choppers, there is going to be a lot of noise. One time I was on a ship, and I had the headsets on and then heard an airplane. Mind you, from under the water, listening in, I can hear an airplane flying over. From that end of the mike to that end of the mike, I could hear it all the way clear. And when I went out there and checked, it was way up there. And that noise, whether you use choppers or airplanes, it's going to be disruptive.” (Akootchook, 1996, as cited in Dames and Moore, 1996)

Billy Oyagak from Nuiqsut said supply ships, choppers, and drilling interfered with whale hunting, making it difficult to find any animals. That year, the hunt required 5 weeks to complete (Oyagak, 1986, as cited in USDOJ, MMS, 1986a).

Wainwright residents object to nearshore or offshore disturbances of any kind because of the displacement of game they already have observed (Aveoganna, 1987; Oktullik, 1996). Residents expressed concerns about potential contamination from oil and about oil-spill-cleanup capabilities (Aveoganna, 1987; Kagak, 1987). Local residents state explicitly that there are no viable substitutes for subsistence-food resources (Ahmaogak, 1987). Hunters have observed waste sites and contamination and the changes that have occurred to fish, caribou, and polar bear behavior and to local ocean conditions (Peetook, 1998; Angashuk, 1998; D. Tagarook and G. Tagarook, 1998). There is a local concern that BLM, in its planning protocol for NPR-A, would designate certain areas off limits to subsistence (Peetook, 1998). Also of concern to the community is the ongoing issue of impact assistance to local communities from oil-activity impacts (Agnasagga, 1986; the traditional knowledge citations in this paragraph all are from USDOJ, BLM and MMS, 2003).

Herman Rexford from Kaktovik recounts that oil ships affect the migration of the whales. He would like to see no ships or exploration off of Kaktovik during the fall whaling time. He knows that the ships are noisy and can affect whaling routes (Rexford, 1986, as cited in USDOJ, MMS, 1986b). Herman Aishanna, former Kaktovik vice-mayor, recounted that “tugs make a lot of noise in the summertime” (Aishanna, 1996, as cited in Dames and Moore, 1996b).

Barrow whaler Gordon Brower, stated in his comments on MMS' 2007-2012 Proposed 5-Year Leasing Program:

Barrow whalers and Nuiqsut whalers have encountered “unacceptable levels” of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Inupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Inupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season's events. Our culture is surrounded by the whale. (Brower, 2005)

Beluga Whales. Hunters have identified noise as affecting beluga whales. Noise from any source traditionally is unacceptable in the whaling cultures of northern Inupiaq and Chukotka peoples (Huntington and Mymrin, 1996; Lowenstein, 1994; Morseth, 1997; Huntington, 1999; Mymrin et al., 1999). Hunters believe that beluga whales have excellent underwater hearing and, for this reason, hunters tend to communicate in quiet tones and with hand signals, trying to make no excessive noise (Lowenstein, 1981; Burch, 1985; George, 1996; U.S. Army Corps of Engineers, 2005). A common theme among the Northwest Alaska coastal communities and along the eastern shore of the Chukotka Peninsula is that beluga whales are sensitive to noise and to the noise of outboard motors in particular (Huntington and Mymrin, 1996; Huntington, 1999; Mymrin et al., 1999). The observations about the effects of noise on beluga whales are widespread and probably very old in traditional knowledge. Negative reactions of belugas to outboard engines in the Kotzebue Sound area were recognized in the 1950s and 1960s and reported in scientific literature as early as 1983 (Fejes, 1996; Foote and Cook, 1960; Frost, Lowry, and Nelson, 1983; U.S. Army Corps of Engineers, 2005).

Kivalina hunters observed that belugas are intelligent and have learned to associate the sound of an outboard engine with danger. They report that Kotzebue hunters hunt with larger and faster boats, and the beluga have learned to go to deeper water when they hear the outboard engine noise from these faster boats. The implication is that belugas retain their experiences with high-speed boats in Kotzebue Sound, making them more wary of hunters in boats with outboard motors, as they migrate northwestward toward Kivalina. Belugas are known to avoid hunters in boats with outboards in Cook Inlet and Kotzebue Sound and can recognize the sound of individual motors used to capture them near Point Lay for satellite-tagging studies (Morseth, 1997; Braund, 1999; Huntington, 1999; U.S. Army Corps of Engineers, 2005).

Local Native hunters in Kivalina are concerned that operational noise, shipping noise, and the presence of the Red Dog port facilities deflect the nearshore migration of the summer beluga stock farther offshore and away from around the port facilities and Kivalina hunting areas, making them less accessible to hunters. Noise from other sources, particularly outboard motors, also is blamed. Port facilities are not operated during the spring beluga migration, but ice colliding with the pilings and repair and maintenance work can produce noise that is transmitted into the water. Some hunters believe port-facility noise, combined with the beluga's memory of past noise at the site, and the physical presence of the facilities, may cause beluga whales to avoid coastal waters near the port area during the spring migration (Braund, 1999, 2000; U.S. Army Corps of Engineers, 2005).

Seals and Other Marine Mammals. Nuiqsut whaling captain Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, as cited in NMFS, 1993b).

Caribou and Other Terrestrial Mammals. According to studies and public scoping comments, low-altitude helicopter and scientific survey flights divert subsistence species from air-transport corridors and survey transects. Nuiqsut mayor Rosemary Ahtuanguaruak described an incident of displacement of subsistence species by aircraft and its effect on hunters:

When I went camping last year, I waited 3 days for the herd, to have a helicopter to divert them away from us. When they were diverted, we went without. We have had to deal with harassment. We had overflights three times while trying to cut the harvest. It is disturbing. The next year we had a helicopter do the same thing, but it was worse. They were carrying a sling going from Alpine to Meltwater, another oil field. It went right over us three times. The herd was right there, and it put us at risk. I had my two young sons with me, and it made me very angry. What am I to do when the activities that have been handed down for thousands of years to our people are being changed by the global need for energy? (Mayor Rosemary Ahtuanguaruak, USDO, BLM, 2004)

Other Nuiqsut residents stated: “Sometimes the aircraft from Alpine chase the caribou up the river,” and “Helicopters are flying around when we are doing caribou and geese hunts. Before Alpine, there was complete silence.” (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004)

Hunters tend to relate aerial activity with subsistence resource deflection. One hunter stated:

It varies whether we have a lot of activities going on. When there are a lot of activities going on, we hardly see any or they [caribou] change their migration route. Oil and gas, airplanes, helicopters, bird survey people—airplane, floatplanes. Either there are less caribou or they are changing migration with activities. I don’t know which. (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004)

Referring to the effect of aircraft on wildlife, Nuiqsut residents stated, “Sometimes the aircraft from Alpine chase the caribou up the river,” and “Helicopters are flying around when we are doing caribou and geese hunts. Before Alpine, there was complete silence” (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004).

Interviewed hunters correlate aerial activity with subsistence-resource deflection. One hunter stated: “It varies whether we have a lot of activities going on. When there are a lot of activities going on, we hardly see any or they [caribou] change their migration route. Oil and gas, airplanes, helicopters, bird survey people—airplane, floatplanes. Either there are less caribou or they are changing migration with activities. I don’t know which....” Therefore, local hunters report that aircraft operation affects the availability of subsistence resources in usual hunting areas (S.R. Braund and Assocs., 2003, as cited in USDO, BLM, 2004).

Birds. Kaktovik resident Mike Edwards stated in public testimony that he thought noise would harm the waterfowl, an important springtime source of food (Edwards, 1979, as cited in USDO, BLM, 1979b).

Nuiqsut whaling captain Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, as cited in NMFS, 1993c).

Wildlife studies, some associated with monitoring and oil- and gas-planning activities, prompted a Nuiqsut resident to observe:

These wildlife folk that see it—they've witnessed, I guess they are wildlife folks, that walk in the country and [are] looking at birds and things in the Colville River Delta, maybe the east side, down by Ulumniak (ph), that's next to—not far from the old Nuiqsut site, they're monitoring these birds and go to and from these places with a chopper—upsets, disrupts, displaces—perhaps some of [our] only opportunity to go get...game, especially caribou, in the area are scared and may...run off because of these impediments that arrive [and] are not natural. Naturally, [we] would walk along the coast where they're at and be able to harvest...caribou. (Ruth Nukapigak, as cited in USDO, BLM and MMS, 1998)

It is important to note that aircraft used for biological surveys have the greatest likelihood of affecting subsistence-harvest patterns, because they cover a large area, last a long time relative to other research activities, and are known to elicit responses from caribou and waterfowl (Nukapigak, 1998, as cited in USDO, BLM and MMS, 1998; Ahtuanguak, 2003, Kaigelak, 2003, and Olemaun, 2003, as cited in USDO, BLM, 2005).

Fishes. Subsistence hunter Isaac Nukapigak, from Nuiqsut, observed that cisco are not spawning out near the Colville Delta anymore, explaining that oil activities in State waters there are having an effect (Nukapigak, 1995). Nuiqsut resident Joan Taleak maintained reservations about local traffic by industrial vessels during her 1983 testimony for a proposed OCS sand and gravel lease sale. She was concerned about the barges hauling gravel conflicting with fishing that had been her way of life since childhood. She recounted her worry that there would be no more whitefish if the sale activities occurred (Taleak, 1983, as cited in USDO, MMS, 1983a).

Subsistence Access. Nuiqsut residents have noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail (USDO, BLM 2004). If resources are diverted from traditional areas, increased travel distances for hunters result in greater expenditures for fuel and equipment because of greater wear and tear on snowmachines, outboards, and four-wheel vehicles. Nuiqsut subsistence users have stated repeatedly that aircraft traffic reduces harvest access and success (Nukapigak, 1998, Ahtuanguak, 2003, Kaigelak, 2003, Olemaun, 2003, cited in USDO, BLM, 2005).

Change in access would result in increased effort, cost, and risks associated with traveling farther. One Nuiqsut resident referred to this effect when she said:

But she's suspect that if activity persists throughout the year, it will alter the hunting and game will no longer be visible and maybe — may cause hunters to go much farther. This has regards to the harvest their subsistence and additional resources safety of hunters when they have to go that much farther for to their subsistence and additional resources” (Ruth Nukapigak 1998 National Petroleum Reserve-Alaska Scoping, Nuiqsut [USDO, BLM and MMS, BLM 1998:Section IV.C.6. Vegetation b. Development (2) Effects of Spills.]).

4.4.1.12.3.2. Traditional Knowledge on Effects from Discharges and Contamination.

Historically, the operation of communication sites by the military, and later contractors, resulted in contamination of surrounding areas with fuel, oil, antifreeze, and other chemicals, which led over time to avoidance of these areas by subsistence harvesters concerned about chemical contamination (USDO, BLM, 2004).

Concerns about contamination extend beyond the study of measurable pollutants to the perception that there may be areas where unknown or unmeasured levels of contaminants in the environment could be affecting both the Inupiat and the resources they harvest. Contaminants may be present in small

quantities deemed harmless, but may accumulate and have serious, long-term, and ongoing health consequences yet unstudied, for both the Iñupiat and the species they on which they rely for subsistence (NRC 2003a; USDOJ, BLM, 2004).

The late Barrow elder, Thomas P. Brower, Sr., commented in a 1978 interview about whale sensitivities to pollution:

I have also seen how sensitive the whales are to water pollution. The commercial whaling ships would always avoid pumping their bilge tanks in the whaling areas. I observed that if some bilge water had to go over the side, it would always be first strained and cleaned before dumping. (NSB, Commission on History and Culture, 1980)

Thomas Brower, Jr. also expressed concerns about drilling contaminants because he has seen wildlife dying from drilling wastes left behind by past drilling activity (USDOJ, BLM and MMS, 1997).

In Barrow, there are also concerns about past contamination and potential new contamination of watersheds from oil exploration (Leavitt, 1980; Aiken, 1997) and seismic impacts on fish and other wildlife (Itta, 1997, H. Brower, 1997).

Onshore, Point Lay residents believe health problems of caribou are related to contaminants (Tucker, 1998).

Wainwright hunters have observed waste sites and contamination and the changes that have occurred to fish, caribou, and polar bear behavior and to local ocean conditions (Peetook, 1998; Angashuk, 1998; D. Tagarook, 1998; G. Tagarook, 1998).

Behavioral responses to the perception of contamination are as real as responses to measurable pollution. The current mayor of Nuiqsut, Rosemary Ahtuanguaruak, outlines stresses placed on resource users in response to real and perceived contamination:

There has been many problems with various developments. And there [are] by-products left all around, areas where you have worked and got your oil and it's left over. We go out and we travel around our land. We go hunting in this land. The by-products of these developments are definitely hurting us. We state that. But yet, in your book it says it's not to a level that's acknowledged as being harmful. Well, we are definitely being harmed by this development. (Ahtuanguaruak, 1997, as cited in USDOJ, MMS, 1997; USDOJ, BLM, 2004)

Contamination and the perception of contamination of subsistence resources may also affect the use of subsistence foods through reduced or abandoned harvests, increased stress about the effects of consuming possibly tainted food, concerns about future availability of subsistence resources, and a decline in the satisfaction of eating subsistence food sources. Responses to known pollution reflect the importance of subsistence foods even in the face of measurable contamination, as a Nuiqsut resident testifying at a public meeting for the Alpine Satellite Development commented: "The ADF&G told us the burbot has mercury, pcbs in the liver, but I eat 'em anyway" (USDOJ, BLM, 2004).

4.4.1.12.3.3. Traditional Knowledge on Effects from A Large Oil Spill and Oil Spill Response and Cleanup.

Bowhead Whales. Marie Adams, from Barrow, observed that an oil spill in the "fragile ecosystem" of the Arctic could devastate the bowhead whale, because these animals migrate through "narrow open-lead

systems,” which could be the preferred path of an oil spill (Adams, 1990, as cited in USDOJ, MMS, 1990b).

Don Long from Barrow stated in 1990: “Any disruption, whether it be oil spill or noise, would only disturb the normal migration [of bowhead whales], and a frightened or a tense whale is next to impossible to hunt” (Long, 1990, as cited in USDOJ, MMS, 1990b).

Having been a whaler since 1916, elder Thomas P. Brower, Sr., from Barrow, in a 1978 interview, gave an extraordinary account of an oil spill in the Arctic and its effects:

In 1944, I saw the effects of an oil spill on Arctic wildlife, including the bowhead. I had been asked to be on the flagship [the *U.S.S. Spica*] of a Navy convoy moving along the Beaufort Sea coast. While I was on the flagship, I saw twenty (20) other ships including several Navy oil tankers. In August 1944 one of the cargo (“Liberty”) ships [the *S.S. Jonathan Harrington*] ran aground on a sandbar off Doctor Island in Elson Lagoon, southeast of Utqiagvik [Barrow]. They needed to lighten the ship to get free. To my disgust, instead of bringing up a tanker to transfer the cargo, they simply dumped the oil into the sea. About 25,000 gallons of oil were deliberately spilled into the Beaufort Sea in this operation. In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area—the Plover Islands—became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear. I have observed that the bowhead whale normally migrates close to these islands in the fall migration. Native families living in the area of Utqiagvik and Elson Lagoon were accustomed to catching small whales in the fall for the winter food supply. But I observed that for four (4) years after that oil spill, the whales made a wide detour out to sea from these islands. Those native families could no longer hunt whales during these years at that location.... If there were a major blowout, all the Inupiat could be faced with the end of their marine hunting, just as those families near Elson lagoon suffered in 1944 through 1948. (Brower, as cited in NSB, Commission on History and Culture, 1980)

Although this spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, the event is remembered more importantly as a time of devastation and deprivation by those who directly witnessed the effects of the spill or those who were told of the event by witnesses. Not only were whales absent for 4 years following the spill, but other resources were absent or occurred in reduced numbers. The people of Barrow who remember the spill consider it evidence that even a relatively small oil spill in a defined area can have lasting effects on subsistence resources and harvests.

Kaktovik residents often have spoken about the threat from oil spills to subsistence food resources. Herman Rexford voiced concern in 1982 that an oil spill would damage the food the whales live on (Rexford, 1982, as cited in USDOJ, BLM, 1982c). During public hearings in 1995, whaling captain Isaac Akootchook worried that an oil spill could occur under the ice and go unnoticed, causing significant damage to subsistence resources (Akootchook, 1995, as cited in USDOJ, MMS, 1995c).

In Nuiqsut, oil spills also are an identified threat. Thomas Napageak stated in his testimony at the Nuiqsut Northeast Area NPR-A scoping meeting that: “The oil industry still does not have adequate technology for oil spill clean up in the Arctic, particularly in rivers, lakes, and the Beaufort Sea. Adequate spill response must be part of any development.” (USDOJ, BLM, 1997).

In Wainwright, residents have expressed concerns about potential contamination from oil and about the lack of oil-spill cleanup capabilities (Aveoganna, 1987; Kagak, 1987).

Beluga Whales and Other Marine Mammals. Nuiqsut elder Sarah Kunaknana was worried that an oil spill could occur and damage the habitat of the bowhead whales and other sea mammals (Kunaknana, 1990, as cited in USDO, MMS, 1990d).

Point Lay hunters believe nearshore or offshore development and oil spills would disturb migrating [beluga] whales, change migration routes, and make them impossible to hunt or adversely affect their population (Huntington and Mymrin, 1996). Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998, as cited in USDO, BLM and MMS, 2003).

Wainwright residents expressed concerns about potential contamination from oil and about oil-spill-cleanup capabilities (Aveoganna, 1987; Kagak, 1987). Local residents state explicitly that there are no viable substitutes for subsistence food resources (Ahmaogak, 1987). Hunters have observed waste sites and contamination and the changes that have occurred to fish, caribou, and polar bear behavior and to local ocean conditions (Peetook, 1998, as cited in USDO, BLM and MMS, 1998; Angashuk, 1998; D. Tagarook and G. Tagarook, 1998, as cited in USDO, BLM and MMS, 1998; USDO, BLM and MMS, 2003).

Caribou and Other Terrestrial Mammals. Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998). Hunters believe health problems of caribou are related to contaminants (Tucker, 1998; USDO, BLM and MMS, 2003).

Birds. Maggie Kovalsky, from Nuiqsut, expressed the fears about effects on Nuiqsut's subsistence foods. She explained that if a spill ever happened, she thinks it would harm a lot of the food they depend on, such as fish and bowhead whale and duck (Kovalsky, 1984).

At hearings for the Northstar Project, Fenton Rexford from Kaktovik said:

We know there are a lot of waterfowl that come from all over the world that go through this area, so that is one of the issues I would like to see in here [the EIS]. They come from all over the world for only a 3-month period, and if there is a spill, that would have a drastic effect. (Rexford, 1996, as cited in Dames and Moore, 1996c)

Fish. Ruth Nukapigak from Nuiqsut spoke in 1983 about the effects she had seen from drilling nearby. She had discovered that fish are afraid of suds or foam and had seen oil in the water. She had heard that when there is an oil spill, it's cleaned up with suds or foam. For those living in Nuiqsut, she believes their food is really going to change from what the oil companies are going to be doing (Nukapigak, 1983, as cited in USDO, MMS, 1983a).

Project Engineering. In a Statewide survey conducted from 1992-1994 by the ADF&G, Division of Subsistence, 80% of the respondents in Nuiqsut believed that industry could not contain and clean up a large oil spill (ADF&G, 1995a). Ice forces can be unpredictable, and Frank Long, Jr., from Nuiqsut expressed local concern that an oil spill could be caused by ice scraping a pipeline or drill pipe, and the resulting spill would damage the entire food chain (Long, 1995, as cited in USDO, MMS, 1995a). In 1996, people in Nuiqsut reiterated their belief that technology does not exist to clean up an oil spill under

the ice; they believe it is a matter of when a spill will occur, not if it will occur. They want assurance against disaster and impact funds set aside for them in case this happens (Dames and Moore, 1996a).

Residents of Barrow are very concerned about oil spills, particularly oil-spill response. In 1983, Percy Nusunginya from Barrow related: “This summer there was supposed to be a demonstration on oil spill response but the weather did not cooperate in the Arctic, so we will expect the industry to have an oil spill on a calm day” (Nusunginya, 1983, as cited in USDO, MMS, 1983c).

Eugene Brower from Barrow expressed the general concern that spill-cleanup procedures under ice do not exist (Brower, 1990, as cited in USDO, MMS, 1990b) and, similarly, in 1995 hearings in Barrow, Edward Hopson asserted that technology is not in place to deal with spills in the Arctic Ocean (Hopson, 1995, as cited in USDO, MMS, 1995b).

Issues about using local expertise and people are prevalent in Nuiqsut. Leonard Lampe, Nuiqsut’s former mayor, reported: “As a member of the village oil spill-response team, we were not allowed to go out onto the ice even for drills under certain very dangerous conditions. So what if a spill occurs under those conditions? There will be no way to clean it up” (Lampe, 1995, as cited in USDO, MMS, 1995a).

Over many years, Kaktovik has voiced its concerns over ice hazards to oil rigs and possible oil spills. In 1979, Philip Tiklul from Kaktovik observed that the ice movements are strong enough to damage an oil rig and cause a spill (Tiklul, 1979, as cited in USDO, BLM, 1979b). Kaktovik subsistence hunter Jonas Ningeok explained that the weather is very unpredictable. Sudden snowstorms can be dangerous. Pressure ridges may form in the ice, damage the oil rig, and cause a spill (USDO, MMS, 1990c). At the same hearing in 1990, Nolan Soloman expressed a similar concern when he stated that oil rigs may fail under the strain of the ice (Soloman, 1990, as cited in USDO, MMS, 1990c). More recently, Fenton Rexford, President of Kaktovik Inupiat Corporation and a subsistence hunter, declared that “the Inupiat here in Kaktovik are adamantly against offshore production until there is proven technology of a cleanup of an oil spill under ice-infested waters. It wasn’t quite proven yet on onshore even” (Rexford, 1996, as cited in Dames and Moore, 1996c).

4.4.1.12.3.4. Traditional Knowledge on Effects from Small Oil Spills.

Bowhead Whales and Other Marine Mammals. In a Statewide survey conducted from 1992-1994 by the ADF&G, Division of Subsistence, 60% of the respondents in Nuiqsut believed that industry could not contain and clean up even a small oil spill (ADF&G, 1995a; Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999).

4.4.1.12.3.5. Traditional Knowledge on Effects from Seismic Surveys.

Bowhead and Beluga Whales, Other Marine Mammals, and Birds. Local residents consistently have indicated that whales and other marine mammals are very sensitive to noise and have been disturbed from their normal patterns of behavior by past seismic activities. Whales can become less predictable and more dangerous to those who hunt them.

Inupiat concern over seismic-survey disturbance is well documented. Don Long from Barrow stated: “Any disruption, whether it be oil spill or noise, would only disturb the normal migration [of bowhead whales], and a frightened or a tense whale is next to impossible to hunt” (Long, 1990, as cited in USDO, MMS, 1990c). Barrow resident Eugene Brower had similar fears about seismic-survey disturbance, believing that noise associated with drilling, seismic-survey, and other exploration activities will disturb the migration of the bowhead whales (Brower, 1995, as cited in USDO, MMS, 1995a). The late Burton

Rexford, then Chairman of the AEWEC, described seismic-survey effects on whales in a 1993 symposium on Native whaling this way:

...I had the...experience in Barrow in 1979, 1980, and 1981 of geophysical seismic work in the ocean, and it's a "no-no" to a hunter during the whaling migration. I know from experience. There were three of us captains that went out whaling in the fall. In those three years, we didn't see one bowhead whale, and we saw no gray whales, no beluga, and no bearded seal. We traveled as far as 75 miles away from our home on the ocean waters in those three years (McCartney, 1995; USDOJ, MMS, 1998a)

Tom Albert, former Senior Scientist for the NSB, related that:

When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about 'spookiness;' when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch" (USDOJ, MMS, 1997a, USDOJ, MMS, Herndon, 2002).

Nuiqsut whaling captain, Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, as cited in NMFS, 1993c). Expressing concern about disturbance, a Nuiqsut resident and whaling captain said in recent testimony for an offshore lease sale that seismic traffic and helicopter overflights "were the cause of whales migrating farther north out to the ocean, 20 miles farther north than their usual migration route" (USDOJ, MMS, 1995b).

The late Thomas Napageak, former whaling captain, President of the Native Village of Nuiqsut, and AEWEC Chairman, related in 1979 that he had not seen one whale while going to Cross Island and believed it was the result of seismic activity in the area (Napageak, 1979, as cited in USDOJ, BLM, 1979b). Maggie Kovalsky from Nuiqsut, testifying in 1984 on Endicott development, explained that with all the noise and activities, bowhead whales, that migrate not far from that area and all the way to Canada, probably will be hurt (Kovalsky, 1984).

In a Statewide survey by the ADF&G, Division of Subsistence from 1992-1994, 86.7% of the respondents in Nuiqsut believed that there were fewer marine mammals as a result of exploration activities on the outer continental shelf (ADF&G, 1995a). At a village meeting for the Northstar Project in 1996, Nuiqsut residents said they feared effects from the project, because it was in the migratory path of the bowhead whales. They made it clear that seismic surveying and transportation noise are of primary concern to Beaufort Sea residents because of their impacts on bowhead whales (Dames and Moore, 1996b; USDOJ, MMS, 2003a).

In a March 1997 workshop on seismic-survey effects conducted by MMS in Barrow, Alaska, with subsistence whalers from the communities of Barrow, Nuiqsut, and Kaktovik, whalers agreed on the following statement concerning the "zone of influence" from seismic-survey noise: "Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles" (USDOJ, MMS, 1998a).

The MMS conducted long-term environmental monitoring in the region for its ANIMIDA monitoring project and, as part of this effort, conducted a multiyear collaborative project with Nuiqsut whalers that describes present-day subsistence whaling practices at Cross Island to empirically verify any changes to whaling due to weather, ice conditions, and oil and gas activities. After the first field season of monitoring in 2001, Nuiqsut whalers reported the following changes in whale behavior and whaling

practices: fewer whales in smaller groups were seen; the need to travel farther from Cross Island to find whales; whales observed were more skittish than in previous years and stayed more in the ice than in open water, spent more time on the surface, and followed more unpredictable paths underwater; whales were more difficult to spot because blows were not as observable as in past years; and whales appeared to be skinnier. Possible causes suggested by the whalers for these behavioral changes were: offshore seismic-survey work for the natural gas-pipeline route; barge supply traffic to Kaktovik for a water- and sewer-construction project; the presence of killer whales offshore and to the east of Cross Island; ice conditions in Canadian waters; air and water traffic to the east of Cross Island; and generally poor weather (Galginaitis and Funk, 2004, 2005; USDO, MMS, 2003a).

In 2002, more moderate ice conditions than in 2001 contributed to whalers not being able to follow certain whales, but not to the same extent as in 2001, when ice conditions were more severe and more whales and in larger groups were seen in 2002 than in 2001. Possible causes suggested by the whalers for these behavioral changes were better ice conditions and very little nonwhaling subsistence activity near Cross Island during the whaling season (Galginaitis and Funk, 2004).

In 2003, conditions were not as good as in 2000 and 2002; however they may have been better or about the same as in 2001, and more whales were observed by whalers during hunting trips in 2003 than in 2002. Possible causes suggested by the whalers were high winds and the lack of ice that could have moderated the effect of the wind (Galginaitis, 2005).

Ice conditions in 2004 were even more moderate than in previous years, and weather prevented scouting for whales on a significant number of days, but not as many days as in 2003. The level of whaling effort, as measured by time spent out on the water, was about twice that of 2003, but still much less than in 2002 or 2001. Whalers found whales relatively close to Cross Island. Possible causes suggested by the whalers were the lack of ice that could have moderated the effects of the wind, weather being generally poor, whales having been more difficult to spot due to wave height, and whales possibly traveling more rapidly than in past years (Galginaitis and Funk, 2006a).

In 2005, whalers encountered a great deal of ice, which was a dramatic change from the previous 4 years. Weather also was very unfavorable, and was dominated by strong east winds. Whalers saw relatively few whales in 2005 compared to previous years, and swells and waves due to wind made spotting and observing difficult; in most cases, they were not able to follow or chase whales long enough to have a good opportunity for a strike. Whalers indicated that whales were traveling fast, not staying on the surface very long, and changing directions in unpredictable ways when first sighted. Possible causes suggested by the whalers were heavy ice cover allowed whales to “hide” and made them more difficult to spot and allowed them to escape more easily and made them more difficult to follow, “spooked” whale behavior was attributed to their reactions to encounters with barges and other vessel activity in the area, the same ice and weather conditions made nearshore waters the preferred operating areas for nonwhaling-vessel traffic and increased potential encounters with whalers (Galginaitis and Funk, 2006b). The ANIMIDA monitoring suggests that changing ice conditions can be as disruptive to the local hunt as anthropogenic disturbance from seismic and other noise-producing activities, and, according to Galginaitis: “the need for a better mechanism to implement the common goal of conflict avoidance for years of extreme environmental conditions as 2005 is quite obvious” (Galginaitis and Funk, 2006b).

Caribou and Other Terrestrial Mammals. After World War II, seismic exploration was a problem to the reindeer, and Thomas Brower, Sr., remembers the seismic wire catching in the hooves of the reindeer and making them lame (Arundale and Schneider, 1987). Fifty years later, seismic activity still is a problem. Karen Burnell, then NSB Planning Director, indicated at the March 1997 Atqasuk Northeast NPR-A Scoping Meeting that inspection of seismic crews is necessary to keep their activities in line with

permitting guidelines that require them to adequately clean up small spills and pick up debris left behind (USDOI, BLM and MMS, 1997, 2003).

Ruth Nukapigak recounted that seismic activity repeatedly has trespassed onto her allotment on the Itkillik River, and that she has been trying unsuccessfully to get compensation since 1974 (USDOI, BLM and MMS, 1997). Oil-exploration crews have been a constant problem to villagers. A cultural plan (*Nuiqsut Paisanitch: A Cultural Plan*) drafted by the village in 1979 noted these objections to field crews by a Nuiqsut resident: “Those oil exploration crews wreck our camps. They tore up our ice cellars at Oliktok and left meat and fish around to rot. They must not know we use those camps” (City of Nuiqsut, 1995).

Nuiqsut residents have testified that seismic activity that leaves trails and sometimes wire cable has caused problems with winter subsistence travel; seismic activity also has threatened traditional sites and is suspected of altering the caribou food chain (Lavrakas, 1996:1, 5; Napageak, 1997).

Subsistence Access. Barrow and Nuiqsut residents testified that recent onshore seismic activity does interfere with overland snowmachine travel (Brower, 2002). Specifically, the deep ruts left in the snow by seismic vehicles create difficult terrain to traverse, resulting in excessive wear and tear on both snowmachines and the sleds that are pulled behind them. Replacement or repair of this equipment used for subsistence harvesting is costly (USDOI, BLM, 2006).

Additionally, Nuiqsut subsistence hunters report that seismic activity displaces game, especially caribou, wolves and wolverine from the area being surveyed (USDOI, BLM, 2007). Because of the harsh conditions during winter, many caribou hunts are based from remote hunting cabins, many of which are located on BLM lands. If seismic activity occurs near a hunter’s cabin locale, the resulting displacement causes the hunter to have to travel farther away. Disturbance of subsistence activities by seismic activities affects subsistence users in the following ways: loss of subsistence food; loss of time; loss of money; increased stress and anxiety; increased risk of equipment failure; and increased risk of loss of life or serious bodily injury. These affects also may put more responsibility on local municipalities to provide rescue response (USDOI, BLM, 2005).

4.4.1.12.3.6. Traditional Knowledge on Effects of Onshore Development.

Access. Community members of Atqasuk have expressed concern for areas critical to calving caribou and nesting waterfowl and have suggested that special management zones be established for these populations. Hunters believe oil development has affected animal migrations and duck populations near Prudhoe Bay and recommend that development should not occur any closer than 15-20 mi to their habitats (Kagak, 1997, as cited in USDOI, BLM and MMS, 1997).

Concerns about access restrictions have been voiced by local residents. Sarah Kunaknana, talking about local subsistence hunters, observed that others have stated that they don’t hunt near Prudhoe Bay anymore because of oil development (S. Kunaknana, in Shapiro, Metzner, and Toovak, 1979). Nuiqsut’s present Vice Mayor Mark Ahmakak, when asked in 1982 if people had been turned back from hunting and fishing areas, answered: “Oh, yes. I have experienced that myself in going out towards Nuiktuk [?] over toward DEW Line station. We have been told by oil company officials that we can’t hunt near development area” (Kruse et al., 1983; Ahvakana, 1990; Dames and Moore, 1996c).

In Northeast Area NPR-A scoping meetings in the village, Thomas Napageak elaborated on the issue of lost access, noting that oil development at Prudhoe Bay and Kuparuk already had cut off Nuiqsut

residents from nearly one-third of their traditional subsistence-harvest areas (Napageak, 1997; Lampe, 1997).

Based on data from Pedersen et al. (2000) and Pedersen and Taalak (2001), as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 78% of the 1993 and 1994 caribou harvests occurring >16 mi from the development east of the Colville River. In addition, 51% of the 1999-2000 harvests occurred >16 mi from the Alpine field development, while 27% occurred 6-15 mi from the Alpine field development (USDOI, BLM, 2005).

Further development anticipated in Pedersen et al. (2000) has come to pass with the development of Alpine, Meltwater, Tarn, Fiord, and other oil fields in the vicinity of Nuiqsut. This ongoing development has contributed to a feeling of being “boxed in” for Nuiqsut subsistence users (Pedersen et al. 2000). A NRC report on the *Cumulative Environmental Effects of Oil and Gas Activities on Alaska’s North Slope* recently concluded that:

On-land subsistence activities have been affected by the reduction in the harvest area in and around the oil fields. The reductions are greatest in the Prudhoe Bay field, which has been closed to hunting, and in the Kuparuk field, where the high density of roads, drill pads, and pipelines inhibits travel by snowmachine. The reduction in area used for subsistence is most significant for Nuiqsut, the village closest to the oil-field complex. Even where access is possible, hunters are often reluctant to enter oil fields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oil fields spread. (NRC 2003a; USDOI, BLM, 2005)

4.4.1.12.3.7. Traditional Knowledge on Effects from Production.

Drilling. Barrow resident Arthur Neakok maintained that ice presents an extreme hazard to ships and drilling (Neakok, 1990, as cited in USDOI, MMS, 1990b). At the same hearing, Eugene Brower expressed concern that multiyear ice would cause problems during drilling (Brower, 1990, as cited in USDOI, MMS, 1990b).

Bowhead and Beluga Whales and Other Marine Mammals. Local residents consistently have indicated that whales and other marine mammals are very sensitive to noise and have been disturbed from their normal patterns of behavior by past drilling activities. Oil activities can make whales become less predictable and more dangerous to hunt. Fenton Rexford from Kaktovik stated that during exploratory drilling in Canadian waters to the east of Kaktovik, “we were not successful or had a very hard time in catching our whale when there was activity with the SSDC [single steel drilling caisson], the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it difficult for our whalers to get our quota” (testimony cited in USDOI, MMS, 1996d). Herman Aishanna reported that in 1985, the SSDC affected Kaktovik whaling even though the rig was idle – “We got no whales that year” (USDOI, MMS, 2001a).

In 1979, Kaktovik residents were concerned about disturbance of migrating whales from drilling noise. Whaling captain James Killbear expressed this concern (Killbear, 1979, as cited in USDOI, BLM, 1979b).

Speaking about the disappointing spring hunt in 1978, when only four whales were caught, Thomas Brower, Sr., from Barrow explained:

The gravel island drilling at this time may make it impossible for the [whaling] captains to supply [the village] with needed winter food supplies. The gravel island drilling at this time may make it impossible for the captains to fill this need for adequate nutrition for the long Arctic winter. (NSB, Commission on History and Culture, 1980)

Herman Aishanna, former mayor, vice mayor, and head of Kaktovik's Whaling Captains' Association, maintained that in 1985 the SSDC did affect the whale subsistence hunt, even though it was idle. He reported: "We got no whales that year" (Aishanna, as cited in NMFS, 1993d). Fenton Rexford, President of Kaktovik Inupiat Corporation (KIC; Kaktovik's village corporation), stated that during exploratory drilling in Canadian offshore waters, "We were not successful or had a very hard time in catching our whale when there was activity with the single steel drilling caisson, the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it very difficult for our whalers to get our quota" (Rexford, as cited in USDO, MMS, 1996d).

Charles Okakok from Barrow also spoke out against drilling because he believed, as many Inupiat subsistence whalers believe and have observed, that the noise may be detrimental to the bowhead whale hunt (Okakok, 1990, as cited in USDO, MMS, 1990b).

According to one Nuiqsut hunter, "The vibration of horizontal drilling bothers animals and makes them afraid. The migration route of the Central Arctic (caribou) herd (CAH) changed because of this" (S.R. Braund and Assocs., 2003, as cited in USDO, BLM, 2004).

Construction.

Bowhead Whales. At village meetings in August 1996 for the Northstar Project, Natives stated that currents can change the bottom contours, potentially affecting the buried pipeline, particularly from river overflow. Testifying at public hearings for a proposed offshore sand and gravel lease, Othniel Oomittuk from Barrow explained that the "water from the dredge operation would also [dis]place the bowhead from their normal fall migration pattern. It drives the whales out, as whalers can't get to them with their small whaling boats" (Oomittuk, 1983, as cited in USDO, MMS, 1983c). Speaking at public hearings in Nuiqsut, Edward Nukapigak, Sr., declared: "If they want gravel, they should not get it from the paths of the animals that we eat" (Nukapigak, 1983, as cited in USDO, MMS, 1983a).

Beluga Whales and Other Marine Mammals. For Point Lay residents, beluga whales are a prized subsistence resource; for this reason, Point Lay residents object to nearshore or offshore noise disturbances (Tukrook, 1987; Tucker, 1996). Hunters believe such nearshore or offshore development would disturb migrating whales, change migration routes, and make them impossible to hunt or adversely affect their population (Huntington and Mymrin, 1996). Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998).

Kivalina traditional knowledge as it relates to construction and operation noises at the Red Dog port facilities states that these activities have affected the subsistence harvest of beluga whales in the area. The total Kivalina harvest of beluga whales declined between 1984 and 1987, even before construction began on the Red Dog Portsite, and has continued to be low in the years since. In other marine waters of Alaska, and in other seas of the world, belugas have adapted to industrial and transportation noises after they have learned that those noises do not represent a direct threat. Beaufort Sea and Cook Inlet data

indicate that the presence and operation of marine transportation facilities have not caused long-term avoidance by belugas (Huntington and Mymrin, 1996). Kivalina hunters contend that either belugas of both spring and summer stocks have not yet become acclimated to port facilities and disturbance or that other factors such as (1) long-term changes in ice conditions, (2) beluga mass mortality reported in Siberian waters, and (3) changes in beluga response to increased noise and activity may have caused the decline in the beluga harvest since Portsite construction began in the late 1980s (U.S. Army Corps of Engineers, 2005).

Caribou and Other Terrestrial Mammals. Pipelines can create physical barriers to subsistence access, making subsistence hunters' pursuit of caribou more difficult (Kruse et al., 1983). Fourteen years later, this same concern was still being expressed by Nuiqsut officials Leonard Lampe and Thomas Napageak, who recounted how designed caribou crossings of pipelines did not seem to work (USDOI, BLM and MMS, 1997).

Inupiat hunters have observed the effect of roads and pipelines on caribou movement in Prudhoe Bay, Kuparuk, and other locations, and one hunter summarized ongoing effects:

The Prudhoe Bay spine road is like a gate: the caribou get corralled in the area by roads, traffic, pipeline reflections, and staging. They get confused. They are scared to cross the pipelines, they are as scary as a grizzly bear would be to the animals. Some caribou are driven south, others are driven to the coast. If more roads are built, then there will be more blockage of the caribou. They will get stuck in the oil fields like a corral. The ones stuck south stay south and get little insect relief, while those going north get to the beach and the coast and get relief. (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDOI, BLM, 2004)

One Nuiqsut hunter observed: "Caribou movement patterns have changed. The herd splits along the pipeline where they used to go straight through, and they congregate in smaller groups spread further apart. Main parts of the herd split either north or south of Alpine, all trying to head towards insect relief" (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDOI, BLM, 2004).

At the MMS Information Update Meeting held March 29, 2000, in Barrow, the ADF&G made a presentation on a draft study of subsistence economics and oil development in Nuiqsut and Kaktovik, which affirmed a strong connection to anthropogenic effects as the cause for the displacement of subsistence hunters from traditional caribou-hunting areas near Nuiqsut during the 1993 and 1994 harvest seasons. Restrictions may be placed on the use of firearms in areas surrounding new oil-related installations (such as roads, landfalls, and pipelines) to protect oil workers and valuable equipment from harm. Structures such as pipelines may limit hunter access to certain active hunting sites (Pedersen et al., 2000; USDOI, MMS, 1987b, 1990b, 1998a, 2001a, 2003a, 2004, 2006a,b; USDOI, BLM, 2004, 2005).

Construction of onshore support facilities would reduce access within current subsistence-use areas as hunters avoid construction areas because of perceived regulatory barriers, loss of cultural privacy, and safety concerns with shooting near industrial development. Ongoing impacts on the community of Nuiqsut are discussed below, because such impacts are emblematic of potential impacts on other subsistence communities in the region.

As a consequence of oil development (based on Pedersen et al., 2000; Pedersen and Taalak, 2001), Nuiqsut caribou hunters tend to avoid development, with approximately 78% of the 1993 and 1994 caribou harvests occurring >16 mi from the development east of the Colville River, 51% of the 1999-2000 harvests occurred >16 mi, and 27% occurred 6-15 mi from Alpine development. Construction of new facilities would contribute to Nuiqsut residents' perceptions of being surrounded by oil development. Oil and gas development could divert subsistence users a distance of 5->25 mi from development

facilities. Given rapidly rising fuel costs on the North Slope, this additional travel would add considerable cost to subsistence harvests (USDOI, BLM, 2004, 2005).

Leonard Lampe, president of the Native Village of Nuiqsut, expressed his belief of the effect of increased traffic on caribou, when he said:

...I feel because of all the traffic between Fairbanks and Endicott, much more increased traffic, that caribou are hesitant to cross the main roads because of all the traffic. I feel that has something to do with the caribou migration as well, because of increased [air] traffic...not just ground, as well as...seismic operations happening all over. (Lampe, 1997; USDOI, BLM and MMS, 1998)

Two years later, Mayor Leonard Lampe stated at an MMS Liberty Project Information Update Meeting in November 1999 that people in Nuiqsut do not see as many calving caribou as they did before. The Tarn Project well has changed their south/north migration, and the Alpine development may affect their east/west migration. Caribou now have to cross three pipelines. At the same meeting, Elder Ruth Nukapigak stated she believed contamination is happening to the caribou from air pollution. They smell the smoke from Alpine and scatter (USDOI, BLM, 2004; 2005).

Pipelines can deter hunting because of the inherent safety concerns involved with hunting near them. One Nuiqsut resident stated:

We don't go down that way to caribou hunt because of the pipeline in there; it is a big obstruction. A lot of times they [caribou] are on the pipeline side and we don't shoot. They [industry] tell us it is OK to shoot, but common sense says not to shoot into pipeline! (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDOI, BLM, 2004)

Other hunters observed changes in the Nuiqsut area in response to existing development, noting that: "Most caribou don't cross Nigliq to Fish Creek anymore. There is noise, activity, traffic, and pipelines." Hunters have observed caribou reactions to pipelines, with one hunter stating: "Some [caribou] get used to pipelines, but it takes years. Shiny pipes and pipes that vibrate feel like a living thing to the caribou and it scares them" (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDOI, BLM, 2004).

Atqasuk residents have expressed concern for areas critical to calving caribou and nesting waterfowl, and have suggested that special management zones be established for these populations. Hunters believe oil development has affected animal migrations and duck populations near Prudhoe Bay, and recommend that development should not occur any closer than 15-20 mi to their habitats (Kagak, 1997). Arnold Brower, Sr., remembers returning from World War II and noticing the extensive environmental damage left by the Navy. He believed that damage done by the Navy near Imagruaq Lake damaged the tundra to such an extent that a drainage ditch was created that lowered the lake's water level and ruined fishing there. After the War, Navy exploration continued and Thomas Brower, Sr., remembers having to negotiate with the Navy so their planes would not buzz his reindeer herd (Arundale and Schneider, 1987; USDOI, BLM and MMS, 1997, 2003; USDOI, BLM, 2005).

Some residents of Kivalina and Noatak affirm that the Red Dog road corridor may be avoided by caribou and possibly by other animals. Hunters in the region have stated that road traffic has at times adversely affected the caribou harvest.

In winter, ice roads also are a problem. One Nuiqsut hunter noted: "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears—have trash inside of them. Seals—plastic pop

rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over” (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004).

Caribou habituation to gravel pads and oil-field infrastructure alters the value of the caribou to subsistence users, who view these habituated caribou as contaminated and not behaving correctly. Frank Long, Jr., stated in the Nuiqsut Alpine Satellite Development Project scoping meeting:

We will have the same problem we did in the Prudhoe Bay and the Kuparuk area with our caribou. Right now I call our caribou that are existing around here that don't go nowhere our 'industrial dope addict caribou.' They already sick and nobody's doing anything about them. (USDO, BLM, 2004)

Sick caribou are increasingly harvested by local hunters. One Nuiqsut hunter related: “I've seen a few sick caribou, with green meat, pus in joints, bare spots. Hard to say what the cause is...” (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004). Pedersen and Taalak (2001) reported five sick caribou harvested that year. Inupiat hunters prefer fast, healthy caribou, instead of habituated caribou, that are perceived to move slower and do not run away from hunters. One hunter stated: “Fast ones are the healthy ones, they are worth taking home” (S.R. Braund and Assocs., 2003, as cited in USDO, BLM, 2004).

Gravel pads create habitat for arctic foxes, which den in the loose gravel of the pad, but an increase in foxes is not necessarily an advantage to subsistence hunters because, as stated by Nuiqsut elder Bessie Ericklook in 1979: “Trapping was abundant east of here. Now, we don't go over [there] because of the oilfield. Just recently, it is known that the foxes are very dirty, discolored, and rabid in that area. Trapping is done elsewhere” (USDO, BLM, 1979c).

Birds. An Inupiat hunter from Barrow observed wildlife displacement associated with gravel pits. He observed that:

These gravel pits that are being used to support these activities, the gravel pits, the geese, when they're migrating from the Lower 48, from out there, they are now going to these gravel pits. They're not following their usual migration anymore. I watched that first hand...over a period of time. So those animals over there are being displaced, is what I'm saying. And I got to see that firsthand over a period of time. (Frederick Tukle, Sr. as cited in USDO, MMS, 2002)

Such diversion of migratory waterfowl can reduce access and availability of these resources to Inupiat hunters.

Atqasuk residents expressed concern for areas critical to nesting waterfowl and have suggested that special management zones be established for these populations. Hunters believe oil development has affected animal migrations and duck populations near Prudhoe Bay, and recommend that development should not occur any closer than 15-20 mi to their habitats (Kagak, 1997, as cited in USDO, BLM and MMS, 1997; Arundale and Schneider, 1987; USDO, BLM and MMS, 1997, 2003; USDO, BLM, 2005).

Fish. Native concern about the effects of development on fish stocks has been evident since the Endicott Project. In 1984, Thomas Napageak, Nuiqsut whaling captain and former Chairman of the AEW, said: “The causeway sticking out into the ocean will change currents along the coast. Furthermore, it will change the migration route of the fish we depend on” (Napageak, as cited in U.S. Army Corps of Engineers, 1984).

Complaints about reduced size of the fish harvested persist in Nuiqsut, and fish are an important subsistence resource, accounting for 33% of the community's total subsistence harvest in 1993 (Pedersen, 1996) and 25% in 1995 (Brower and Opie, 1997). Nuiqsut fish harvesters have noted that arctic cisco have decreased, coinciding with the operation of Endicott's water-treatment plant (Dames and Moore, 1996a). Wilber Ahtuanguak, from Nuiqsut, maintained almost 2 decades ago that there "aren't as many whitefish since the oil companies started drilling at Flaxman Island" (Ahtuanguak, 1979, as cited in USDO, BLM, 1979a); Joseph Akpik, from Nuiqsut, asserted that offshore exploration would affect the cisco population (Akpik, 1995, as cited in USDO, MMS, 1995a; USDO, BLM, 2005).

In 1979, Nuiqsut resident Nannie Woods talked about fish and caribou being less abundant at the Sagavanirktok River since the development at Prudhoe Bay. She explained that the river's tributaries also did not have as many fish, and that fewer caribou were there now than there used to be in the summer (Woods, 1979, as cited in USDO, BLM, 1979a).

Subsistence hunter Isaac Nukapigak from Nuiqsut observed that cisco are not spawning near the Colville Delta anymore, explaining that oil activities in State waters there are having an effect (Nukapigak, 1995, as cited in USDO, MMS, 1995a). Nuiqsut resident Joan Taleak maintained reservations about local traffic by industrial vessels during her 1983 testimony for a proposed OCS sand and gravel lease sale. She was concerned about the barges hauling gravel conflicting with fishing that had been her way of life since childhood. She recounted her worry that there would be no more whitefish if the sale activities occurred (Taleak, 1983, as cited in USDO, MMS, 1983a).

At an MMS Liberty Project Information Update Meeting in November 1999 in Nuiqsut, Elders Lloyd Ipalook, Alice Ipalook, and Ruth Nukapigak said that fish stocks were very low. Alice Ipalook and Ruth Nukapigak both noted that they had seen a decrease in whitefish since the work at Kalubik [1992], and that there used to be 100-200 fish caught per day versus 6-9 per day now (USDO, MMS, 2002).

Arnold Brower, Sr. remembers returning from World War II to Atqasuk and noticing the extensive environmental damage left by the Navy. He believed that damage done by the Navy near Imagruaq Lake damaged the tundra to such an extent that a drainage ditch was created that lowered the lake's water level and ruined fishing there (USDO, BLM and MMS, 1997, 2003; USDO, BLM, 2005).

Ice roads that are grounded to the bottom of waterways change the normal patterns of breakup and reduce fish habitat. One subsistence fisher described his recent hunting trip by boat: "A few days ago [late June], the ice was out 7 miles; we followed it to Thetis Island. Usually the ice is out around Thetis Island, but the ice road was intact and it kept the ice from going out. We almost got boxed in" (S.R. Braund and Assocs., 2003, Field Interviews, as cited in USDO, BLM, 2004).

Polar Bear. Trash has become an issue in subsistence areas close to oil- and gas-related facilities. A Nuiqsut hunter explained that: "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears—have trash inside of them. Seals—plastic pop rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over" (S.R. Braund and Assocs., 2003, Field Interviews, as cited USDO, BLM, 2004).

Subsistence Access. Subsistence hunters have expressed a preference for hunting away from industrial- activity areas for safety and other reasons. As noted in NRC (2003a): "Even where access is possible, hunters are often reluctant to enter oil fields for personal, aesthetic, or safety reasons. There is, thus, a net reduction in the available area, and this reduction continues as the oil fields spread." Reduction in available area would alter access, and this change in access would result in increased effort, cost, and risks associated with traveling farther (USDO, BLM and MMS, 1997, 2003; USDO, BLM, 2004, 2005).

Barrow resident Charles Brower, as early as 1986, stated that an onshore pipeline could interfere with subsistence access; additional hunting restrictions would occur, requiring a permit (Brower, 1986).

Local Nuiqsut residents have expressed concerns about access restrictions. Sarah Kunaknana stated that others say that subsistence hunters do not hunt near Prudhoe Bay anymore because of oil development (Kunaknana, as cited in Shapiro, Metzner, and Toovak, 1979). Nelson Ahvakana from Nuiqsut was concerned that areas that are supposed to be left open for subsistence hunting effectively will be closed because of increased security at the new drill sites, and that access to subsistence resources will be restricted. In view of the areas near Prudhoe now off limits to subsistence, access issues are viewed as critical. Arnold Brower, Jr., NSB Northeast Area NPR-A Coordinator, said that similar firearm restrictions from NPR-A leasing and development with those already existing around Prudhoe Bay oil-development sites would create additional detours for subsistence hunters (Ahvakana, 1990, as cited in USDOI, MMS, 1990d; USDOI, BLM and MMS, 1997, 2003; USDOI, BLM, 2004, 2005).

Concerns about restricted subsistence access on the North Slope, particularly around Nuiqsut, take on even more meaning as the Northstar Project, development at the Alpine field, and leasing in the NPR-A become realities. During a 1996 meeting on the Northstar Project in Nuiqsut, two Nuiqsut men described being denied access to fishing and hunting areas around Prudhoe operations, even though they had traditional rights to be there. They did not want new projects to restrict or deny access (Dames and Moore, 1996b). A whaler voiced concern that BPXA or the Federal Government would block the whalers from taking their traditional whaling route to Cross Island, if a production facility were developed offshore at Liberty Island. They prefer to travel within the barrier islands, because the islands offer protection from the open sea (Dames and Moore, 1996b; USDOI, BLM, 2004).

Nuiqsut residents have concerns over pipeline construction restricting subsistence access, and have told BLM that it must identify stipulations to protect subsistence-hunting sites, traditional fish camps, and access routes from development impacts (C. Brower, 1986; Hepa, 1997).

Project Engineering. At village meetings in August 1996 for the Northstar Project, Natives stated that currents can change the bottom contours, potentially affecting the buried pipeline, particularly from river overflow (Dames and Moore, 1996a). Nuiqsut whaling captains believe that Seal Island, as planned for Northstar, needs more protection from natural elements to be considered safe by the community (Dames and Moore, 1996b).

At the same meeting, Native residents expressed concern about the possibility of steel and concrete fatigue over the 15-year project life of the Northstar Project. In light of the recent BPXA onshore spill at Prudhoe Bay, these fears do not seem unfounded (Dames and Moore, 1996b; Mufson, 2006).

4.4.1.12.4. Anticipated Effects Under Alternative 1. The potential effects to subsistence-harvest patterns were described in Sections 4.4.1.12.1-8. This section describes the impact on subsistence-harvest patterns resulting from the incremental impact of Alternative 1, the no action alternative, and adding it to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such actions. Past and present cumulative actions are described below as they have impacted affected subsistence-harvest patterns. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures are described in Section 4.4.1.12.

General Effects. The following general factors are considered in determining the anticipated effects from this alternative:

(1) **Timing.** Exploration activities typically occur during the open-water period. This largely eliminates potential effects during spring migration for marine mammals important to the subsistence hunt, unless exploration vessels traverse the spring lead system. Effects are possible during open-water periods, where activities potentially could affect marine mammal species or the subsistence hunt for these species. Production operations would take place year-round, and effects would be possible from a variety of sources throughout the year.

(2) **Residence Time and Periodicity.** Effects vary based on whether activity in the area is short-term or long-term and whether it involves passage through an area on a frequent or intermittent basis. During exploration, drill ships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft likely would need to make trips between the drillship and shore to deliver personnel and equipment. Residence time and periodicity of drillships and support vessels during exploration could affect migrations of these marine mammal species and the subsistence hunts for these species.

(3) **Spatial Extent.** The lease-sale area is large, and the area explored in any given season is small by comparison. Beyond the footprint of a seismic vessel or drillship, consideration must be given to the area affected by noise, support-vessel traffic, and other factors, one important factor being the number of multiple seismic and/or drilling activities conducted in a single open-water season.

(4) **Environmental Factors.** Weather, currents, wind, and ice conditions all influence the level of potential effects. Ice conditions influence by seasonal weather or longer term climate change alter locations of marine mammal species and such relocations of resources drive the difficulty of locating and hunting these resources.

(5) **Oil Spills.** If an oil spill occurred where there were concentrations of marine mammals or in traditional subsistence areas, impacts to these species and the hunt due primarily from tainting concerns to arctic seas, resources, and shorelines and the consequent disruption of the hunt would represent a major effect.

Extent of mortality that could result from oil spills from oil production is extremely difficult to estimate. The potential that a commercial field would be discovered in the Chukchi Sea is $\leq 10\%$ and about 20% in the Beaufort Sea. It also is uncertain that oil would be spilled. As stated in the Beaufort Sea multiple-sale EIS, the likelihood of at least one spill of at least 1,000 bbl (42,000 gal) during the life of the project (~26 years) was estimated to be 8-10%. The extent of mortality and tainting of marine mammals and disruptions to their hunts would be influenced largely by the number, volume, trajectory, and timing of the spill event, as well the length of time that oil remains in the environment.

A larger number of small spills (<1,000 bbl) could occur after production activities begin, but most of these would be contained and not reach open water; and their smaller size limits their spread and persistence because of the actions of weathering and other environmental factors. The low probability of such events, combined with the uncertainty of the location of the spill, the seasonal nature of the marine mammal resources, and the specific locations of preferred harvest areas, make it highly unlikely that chronic small spills or even a large oil spill would contact large numbers of marine mammals or preferred harvest areas. Even if marine mammals were present in the vicinity of an oil spill, they might not be contacted by the oil due to avoidance behavior, ice conditions, or weather patterns. Nevertheless, Inupiaq cultural concerns for tainting of resources or hunting areas, even if such resources or areas were not directly contacted by an oil spill, could curtail local subsistence harvests.

The MMS requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment. Numerous small or large spills from OCS oil and gas activities are considered high effect, low probability events in terms of routine exploration, development, and production activities. Pipeline spills generally are smaller and less damaging than tankering spills. It also is difficult to estimate the potential for chronic small spills or a large spill to originate from non-MMS sources (private, commercial, and State of Alaska actions) within the Chukchi and Beaufort seas. Increasing vessel traffic and bulk-fuel deliveries appear to present the most obvious dangers to marine mammal resources and hunts in the Arctic.

Summary of Specific Effects. Cumulative effects on subsistence-harvest patterns include other past, present, and reasonably foreseeable projects on the North Slope. These projects could impact subsistence resources because of potential noise and traffic disturbance, oil spills, or disturbance from construction activities associated with on- and offshore pipelines, landfalls, and ice roads, etc. Noise and traffic would occur from vessel and aircraft supply efforts and from building, installing, operating, and maintaining production facilities. Direct effects include delay or deflection of resource populations' movements and mortality; indirect effects include destruction or degradation of habitat and changes in productivity.

To understand cumulative effects on subsistence-harvest patterns, we must recognize three major characteristics of North Slope communities: (1) they rely heavily on bowhead whales, caribou, and fish in the annual average harvest; (2) subsistence-hunting ranges overlap for many species harvested by Native communities; and (3) subsistence hunting and fishing are central cultural values in the Inupiat way of life. Chronic cumulative biological effects to subsistence resources would affect their harvests. Potential effects from oil spills and noise disturbance could affect (a) seal hunting during the winter; (b) whale, seal, bird, and caribou hunting in spring; and (c) whale, seal, bird, and caribou hunting during the open-water season (USDOJ, MMS, 2003a).

Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development reduces the availability of resources or alters their distribution patterns. Cumulative effects to bowhead whales and other marine mammals is a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas and the traditional bowhead whale harvest could be adversely affected. The same could be true for beluga whales, walruses, and seals (USDOJ, MMS, 2003a). The disruption of bowhead whale harvests could result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals—making them more skittish, for example—in reaction to OCS activities. The greater the degree of activity onshore and oil and gas development in Federal, State, and Canadian waters, as measured by increases in seismic noise, vessel traffic, east-to-west development, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. If gas development occurs on the North Slope, it is likely that development would occur in portions of the foothills, further expanding the areas subsistence users would likely avoid development facilities and accompanying security concerns create a literal avoidance situation for subsistence hunters as the Nuiqsut narrative describes in detail. To a large extent existing stipulations and required mitigation have mitigated such potential effects and may continue to do so (USDOJ, MMS, 2007d).

In the past, ongoing seismic operations have been seasonally timed and monitored to minimize conflicts with the migration and the subsistence hunt, but multiple seismic actions coupled with exploratory drilling in the region have stressed past cooperative strategies and protocols, specifically the CAA process between industry and whaling captains. The MMS has proposed to replace this protocol by requiring industry to submit an AMMP that will provide provisions to prevent unreasonable conflicts to subsistence harvests. These plans must address the timing, coordination, and monitoring of potential industry activities to prevent conflicts to whales and subsistence whalers. In the only case of a drilling operation

extending into whale migration areas—the Northstar development—monitoring has tended to prevent conflicts with whales and whalers (USDOI, MMS, 2003a).

If a large oil spill occurred and affected any part of the bowhead whale’s migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead’s immigration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales still would be available. Tainting concerns also would apply to walrus, seals, polar bears, fish, and birds (USDOI, MMS, 2003a).

Biological effects to subsistence resources may not affect species’ distributions or populations, but disturbance could force hunters to make more frequent and longer trips to harvest enough resources in a given season. In Beaufort Sea communities, the hunt for beluga whales follows more flexible hunting patterns and this may reduce the effects of noise and disturbance. Hunters can take belugas in ice leads and open water at different times for a 6-month period, and belugas are not the whale species preferred in potentially affected communities. In the unlikely event that a large oil spill occurred, it could cause potential short-term but significant adverse effects to longtailed duck and king and common eider populations. Subsistence-bird resources could experience short-term, local disturbance, but such disturbance could cause waterfowl to avoid productive subsistence-hunting sites. For the spring subsistence-waterfowl harvest, cumulative loss of habitat from development activities and population losses from oil spills significantly could disrupt harvests. An onshore pipeline spill that contacted rivers and streams could kill many fish and affect these fish populations. A potential loss of polar bears from oil-spill effects could reduce their availability locally to subsistence users, although polar bears most often are hunted opportunistically by North Slope subsistence hunters while in pursuit of more-preferred subsistence resources (USDOI, MMS, 2003a).

Limited monitoring data prevent effective assessment of cumulative subsistence-resource damage; resource displacement; changes in hunter access to resources; increased competition; contamination levels in subsistence resources; harvest reductions; and increased effort, risk, and cost to hunters. We cannot project effects properly without monitoring harvest patterns and the effectiveness of mitigating measures, and any effective monitoring regime must include serious attention to traditional Inupiat knowledge of subsistence resources and practices. Development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from nonsubsistence hunters for fish and wildlife (Haynes and Pedersen, 1989; Pedersen et al., 2000; USDOI, MMS, 2003a).

In a case study by Pedersen et al. (2000), they recommended that government, industry, and local subsistence representatives collaborate in assessing the interaction of subsistence patterns and the expansion of industrialized areas on the North Slope. They believed this coordination should include: (1) meaningful and increased participation by local subsistence representatives from affected Inupiat communities in leasing, exploration, development, and production activities; (2) direct involvement of local subsistence representatives and locally trained staff in the development of protocols to implement monitoring, assessment, and evaluation of the effectiveness of subsistence protection plans and mitigation; (3) a commitment to long-term collection of time-series data on the quantitative, temporal, and spatial dimensions of household subsistence-harvest activities in affected Inupiat communities to provide effective measures for monitoring, assessing, and evaluating effects on subsistence activities; and (4) more and better coordinated studies between industry and local subsistence representatives on the cumulative impacts on subsistence resource productivity, harvest activities, and harvester access.

It is difficult to disaggregate the cumulative effects of oil development in the region (particularly onshore) from more relatively recent processes of extreme local social change. Proper assessment of cumulative

effects on the North Slope is critical, but separating the effects of an oil-development project from those of general social change can be difficult (USDOJ, MMS, 2003a). Nevertheless, according to Worl, writing in one of the early research reports of contemporary subsistence uses by Iñupiat people, the “fate of subsistence lies not so much at the level of the hunter pursuing his game, but rather at the level of external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits” (NSB, Commission on History and Culture, 1980; Berger, 1988).

4.4.1.12.4.1. Anticipated Effects From Vessel Disturbance. The potential effects to subsistence-harvest patterns from vessel disturbance were described in Section 4.4.1.12.6.1.

Cumulative Past and Present Actions. The majority of vessels transiting through the Beaufort Sea and Chukchi Sea Planning Areas travel within 20 km of the coast and would include, at a minimum, vessels used for fishing and hunting, cruise ships, icebreakers, Coast Guard vessels, supply ships, tugs, and barges that would include the seasonal supplying of local communities (usually one large fuel barge and one supply barge visit local villages each year); Prudhoe Bay sealifts (anywhere from 0-3 per year); West Dock vessel traffic for Northstar personnel (although crewboat traffic largely has been replaced by hovercraft and helicopter traffic) and resupply transport; barging for NPR-A drilling equipment; and, Canadian vessel traffic (LGL Alaska Research, 2006). Arctic marine transport in the region is likely to increase: from 1977 through 2005, there were 61 North Pole transits (17 in the last year alone) and 7 trans-Arctic voyages (Brigham and Ellis, 2005). Increased cargo transport in the Arctic (primarily outside the Chukchi and Beaufort seas area) also is expected due to increased petroleum and mining activities and the need for future supplies for these industries (PAME, 2000).

Bowhead and beluga whales and other marine mammals have experienced temporary, nonlethal effects from exposure to noise from vessel traffic. Cumulative noise and disturbance comes from brief and local disturbance or displacement (USDOJ, MMS, 2003a). Barge traffic to the North Slope and some icebreaker activity could affect how seals are distributed near the activity during high levels of activity. However, some seals would habituate to marine and air traffic, industrial noise, and human presence. Displacement from cumulative industrial activities likely would not affect the overall abundance, productivity, or distribution of ringed seals, bearded seals, walruses, and beluga whales in the region. Noise also would be unlikely to affect the few whales that could be in lagoon entrances or inside the barrier islands because of the rapid attenuation of industrial sounds in a shallow-water environment. Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it likely would not affect beluga or gray whales (USDOJ, BLM and MMS 2003; USDOJ, BLM, 2004).

An increased amount of oil-related vessel traffic makes it likely that subsistence-harvest activities could be disrupted occasionally by boat traffic. Because most marine-hunting activity occurs within a wide area of open water, such interruptions typically could cause boat crews to hunt longer or take extra trips but are not expected to significantly reduce overall harvests of marine mammals or seabirds. The one exception could be walruses where, in recent years, local hunters have noted that the abundance of walruses in retreating spring pack ice has declined coincidental with the appearance of large tugs pulling supply barges (USDOJ, FWS, 2006b). Because of their short and ice-condition-dependent seasons, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine mammal hunting (other than beluga whaling). Because the bowhead whale harvest in all communities except Barrow tends to be quite small—one to two whales per year—noise disturbance from icebreakers and other vessels could cause this small harvest to become locally unavailable for the entire season. Such activities already occasionally have affected subsistence hunting. For example, Kaktovik whalers stated that their 1985 fall whaling season was adversely affected by vessels related to oil development operating in open-water areas. Cumulatively effects from noise and disturbance on the

beluga whale harvest could increase. Increased vessel activities in the Beaufort and Chukchi seas could impact the beluga harvest by causing beluga whales to become locally unavailable for certain critical periods (USDOJ, MMS, 2006a).

Cumulative effects to bowhead whales are a serious concern. If increased noise were to cause whales to deflect from their normal migration route, they could be displaced from traditional hunting areas, and the traditional bowhead whale harvest could be adversely affected. Ideally, ongoing seismic operations would be timed seasonally and monitored to prevent conflicts with the migration and the subsistence hunt. In the past, most projected reasonably foreseeable development projects would be expected to be closer to shore and away from traditional bowhead whale migration and harvest areas, but this pattern seems to be changing (USDOJ, BLM and MMS, 2003).

The International Whaling Commission (IWC) sets the quota for the number of bowhead whales that Alaska Inupiat may harvest. This quota is based on both the biological status of the bowhead whale stock and the documented Alaska Eskimo cultural and subsistence need for bowhead whales. It is likely that the IWC would perceive increased industrialization offshore (including development of coastal staging areas, heightened interest in adjacent onshore areas, and increased oil spill risks), as placing increased pressure on the endangered bowhead whale population. As industrialization proceeds along the Alaska North Slope, it will increase noise, vessel traffic, and the potential for an oil spill in the Beaufort Sea. In response to concerns that noise, vessel traffic, and the potential for a catastrophic oil spill poses a threat to the feeding grounds of the western Pacific gray whales, the IWC has already passed a resolution that the onset of oil and gas development programs is of particular concern with regard to the survival of this population. Because the North Slope is the fall migration path and feeding grounds of the bowhead whale, it is likely that the IWC would seriously consider the effects of industrialization on the bowhead whale population. Although the IWC is unable to directly control industrial activities, they are able to control the Inupiat subsistence harvest quota and could reduce this quota as a means of protecting a species confronted with the effects of increased industrialization. If the IWC (which sets the quota and NMFS which passes it on to the AEWG to set for individual communities) considers the threat of industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Inupiat communities of the North Slope as well as to Inupiat in other communities who receive whale meat from the harvest (USDOJ, BLM and MMS, 1998).

4.4.1.12.4.2. Anticipated Effects From Aircraft Disturbance. The potential effects to subsistence-harvest patterns from aircraft disturbance were described in Section 4.4.1.12.1.2.

Cumulative Past and Present Actions. Aircraft are used in the Beaufort and Chukchi seas for transporting supplies and personnel to local communities, industrial complexes (e.g., Deadhorse, Prudhoe Bay, Northstar, Alpine, and Red Dog Mine), and vessels related to seismic and project support, research for marine mammal and marine bird surveys, recreation and tourism, monitoring weather and oceanographic conditions, and military exercises and surveillance. The MMS continues its annual bowhead whale aerial survey program, which usually begins September 1 and ends October 20. All surveys would be conducted at an elevation between 1,000 and 1,500 ft. Other marine mammal-research-related aerial surveys are likely to occur in the Arctic Ocean and possibly at elevations lower than 1,000 ft. It is likely that subsistence-harvest activities are disrupted occasionally by air traffic. Because most marine-hunting activity occurs within a wide area of open water, such interruptions typically may cause boat crews to hunt longer or take extra trips, but they are not expected to significantly reduce overall harvests of marine mammals or seabirds. Increased air traffic and vessel activities in the Chukchi Sea could impact the beluga harvest by causing beluga whales to become locally unavailable for certain critical periods.

4.4.1.12.4.3. Anticipated Effects From Discharges. The potential effects to subsistence-harvest patterns from discharges were described in Section 4.4.1.12.1.3.

Cumulative Past and Present Actions. Cumulative oil and gas activities will contribute to increasing concentrations of contaminants in the Arctic that may be affecting marine mammal populations. The cumulative effect of exploratory discharges probably would lead to minor effects on marine mammals, birds, and fish in offshore locations. The discharge of produced water year-round anywhere probably would lead to moderate effects, as contaminants on the surface could impact birds in the vicinity of the discharge sites. Any discharge proposals would be reviewed in detail by MMS and EPA.

4.4.1.12.4.4. Anticipated Effects From Large Oil Spills. The potential effects to subsistence-harvest patterns from large oil spills were described in Section 4.4.1.12.1.4.1.

Cumulative Past and Present Actions. Effects of a large oil spill in Federal or State waters most likely would result in nonlethal temporary or permanent effects on bowhead whales. However, we reiterate that due to the limitations of available information and due to the limitations inherent in the study of baleen whales, there is uncertainty about the range of potential effects of a large spill on bowhead whales, especially if a large aggregation of females with calves were to be contacted by fresh oil. The NMFS has concluded that, given the abundance of plankton resources in the Beaufort Sea, it is unlikely that the availability of food resources for bowheads would be affected. Because of existing information available for other mammals regarding the toxic effects of fresh crude oil, and because of inconclusive results of studies on cetaceans after the EVOS, we are uncertain about the potential for mortality of more than a few individuals. Such potential probably is greatest if a large aggregation of feeding or milling whales, especially an aggregation containing relatively high numbers of calves, was contacted by a very large slick of fresh oil. Such aggregations occasionally have been observed in open-water conditions north of Smith Bay and Dease Inlet, near Cape Halkett and other areas (USDOJ, MMS, 2007d). Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's immigration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales still would be available. Tainting concerns also would apply to polar bears, seals, fish, and birds. Biological effects on other subsistence resources might not affect species' distributions or populations, but disturbance could force hunters to make more frequent and longer trips to harvest enough resources in a given season (USDOJ, BLM and MMS, 2003).

If a large oil spill contacted the coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to significant long-term impacts to nearshore habitats of bird and fish resources, as well as other subsistence resources and hunts. Subsistence-bird resources might experience only short-term, local disturbance, but such disturbance could cause waterfowl to avoid productive subsistence-hunting sites. For the spring subsistence-waterfowl harvest, cumulative loss of habitat from development activities and population losses from oil spills could significantly disrupt harvests. An onshore pipeline spill that contacted rivers and streams could kill many fish and affect these fish populations. Although polar bears are most often hunted opportunistically by North Slope subsistence hunters while in pursuit of more preferred subsistence resources, a potential loss of polar bears from oil-spill effects could reduce their availability locally to subsistence users (USDOJ, BLM and MMS, 2003).

In the Chukchi Sea the active-ice, or ice-flaw zone is an important habitat for marine mammals such as bowhead and beluga whales, walrus, seals, and other marine mammals. Seals, walrus, and beluga whales would be most vulnerable to spills contacting this zone; polar bears would be most vulnerable to spills contacting the flaw zone or the coast. Offshore spills obviously would pose a higher risk to marine

mammals than onshore spills, but along the coast of the Chukchi Sea Planning Area, some aggregations of seals and walrus and a small number of polar bears could be contaminated by onshore spills that reach marine waters and could suffer lethal or sublethal effects. The most noticeable effects of potential oil spills from offshore oil activities would be through contamination of seals, walruses, and polar bears, with lesser effects on beluga whales (USDOJ, MMS, 2007d).

4.4.1.12.4.5. Anticipated Effects From Small Oil Spills. The potential effects to subsistence-harvest patterns from small oil spills were described in Section 4.4.1.12.1.4.2.

Cumulative Past and Present Actions. Considering the small additive effects of onshore oil spills from the Trans-Alaska Pipeline System (TAPS) on individual subsistence resources, measurable cumulative effects on subsistence harvests are unknown. Small onshore spills could have a small additive effect on terrestrial mammal habitats near pipelines, roads, and other facilities. Small spills are expected to be cleaned up before substantial losses occur, and cleanup at the spill site would frighten caribou and other terrestrial mammals away from the spill and prevent contact with the oil. Small spills are not expected to significantly affect bird species occurring in the planning areas. In winter, onshore pipeline spills on the North Slope and along the TAPS would not be expected to affect fish, because their likelihood of contacting fish habitat is very low. In summer, fish and food resources in a small waterbody with restricted water exchange likely would be harmed or killed from a small spill of sufficient size. Small numbers of fish in the immediate area of an onshore oil spill would be killed or harmed, but small oil spills would not be expected to have measurable cumulative effects on fish populations. Most onshore spills occur on gravel pads, and their effects do not reach surrounding vegetation. About 20-35% of past crude oil spills have reached areas beyond pads. Because winter spans most of the year, about 60% of the time spills occur when workers can clean up oil on the snow cover before it reaches exposed vegetation (USDOJ, MMS, 2003a).

4.4.1.12.4.6. Anticipated Effects From Oil-Spill Response and Cleanup. The potential effects to subsistence-harvest patterns from oil-spill response and cleanup disturbance were described in Section 4.4.1.12.6.4.3.

Cumulative Past and Present Actions. Noise and disturbance from oil-spill cleanup activities associated with oil spills from exploration, development, and production operations could disturb marine mammals and subsistence harvests.

4.4.1.12.4.7. Anticipated Effects From Seismic Surveys. The potential effects to subsistence-harvest patterns from seismic surveys were described in Section 4.4.1.12.1.5.

Cumulative Past and Present Actions. Multiple marine seismic surveys (2D, 3D, high-resolution site-clearance, and ocean-bottom-cable [OBC] surveys) have occurred and will occur in both the Chukchi and Beaufort seas, both on- and offshore. There also are a number of nonoil- and gas-related scientific seismic surveys that have been and will be conducted in and near the Beaufort Sea and Chukchi Sea Planning Areas (USDOJ, MMS, 2006a).

Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, there is the potential that seismic surveys will continue for sometime in the Chukchi and Beaufort seas. Surveys beyond 2008 depend on: (1) the amount of data that is collected in 2006 and 2007; (2) what the data indicate about the subsurface geology; and (3) the results of Beaufort Sea Sale 202 and Chukchi Sea Sale 193. Potential seismic-survey activity beyond 2006 was addressed in the final EIS for the OCS Oil and Gas Leasing Program, 2007 to 2012 (USDOJ, MMS, 2006a).

Noise and disturbance from on-ice seismic surveys could disturb and displace breeding ringed seals. The cumulative effect of seismic exploration on marine and coastal birds probably would be moderate, particularly to birds staging or molting in the Ledyard Bay area. The cumulative effect of seismic exploration on fish resources probably would be minor. Cumulative impacts from seismic surveys are likely to result in some incremental cumulative effects to bowhead whales through the potential exclusion or avoidance of bowhead whales from feeding or resting areas and disruption of important associated biological behaviors. However, the impact analysis of the likely range of effects and the likelihood of exposures resulting in adverse behavioral effects supports a conclusion that the activities would result in no more than temporary adverse effects and less than stock-level effects. Mitigation measures imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury), reduce the potential for population-level significant adverse effects on bowhead whales, and avoid any unmitigable adverse impacts on their availability for subsistence purposes (USDOJ, MMS, 2007d).

Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s had a lasting population-level adverse effect on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea. However, data are inadequate to fully evaluate potential impacts on whales during this period, including the duration of habitat use effects or numbers and types of individuals that did not use high-use areas because of the activities. Oil and gas exploration activities, especially during the 1990s and early 2000s, have been shaped by various mitigation measures and related requirements for monitoring. Such mitigation measures, with monitoring requirements, were designed to, and probably did, reduce the impact on the whales and on potential impacts on whale availability to subsistence hunters. We assume future activities in Federal OCS waters would have similar levels of protective measures. However, we cannot be certain of what mitigation measures will be imposed in State waters or what the impacts of land-related support activities will be. We also note that the effectiveness of mitigations is not entirely clear; it also is not clear when, or if, the level of activity might become large enough to cause effects that are biologically significant to large numbers of individuals. Looking at each action separately indicates that there should not be a strong adverse effect on this population. Future activity in the OCS has the potential to contribute a substantial increase in noise and disturbance that will occur from oil and gas activities in State waters and on land as well as increase the spill risk to this currently healthy population. It is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales (USDOJ, MMS, 2007d).

Access to subsistence resources and subsistence-hunting areas and the use of subsistence resources could change, if cumulative seismic disturbance reduces the availability of resources or alters distribution patterns. Cumulative effects to bowhead whales are a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas, and the traditional bowhead whale harvest could be adversely affected. Historically, bowhead whales have been exposed to multiple sources of human-caused noise disturbance and are likely to be exposed to similar sources of noise disturbance in the foreseeable future. Required protective mitigation, such as required industry AMMPs and required mitigation under IHA requirements, as defined by NMFS and FWS is expected to reduce noise disturbance impacts (USDOJ, MMS, 2006a).

4.4.1.12.4.8. Anticipated Effects From Habitat Loss. The potential effects to subsistence-harvest patterns from habitat loss were described in Section 4.4.1.12.1.6.

Cumulative Past and Present Actions. On the North Slope, development has directly covered about 7,000 acres through the construction of 350 mi of roads, 89 pads, 4 airstrips, and 14 gravel mines. The

mines cover more than 1,500 acres. Development in the Prudhoe Bay and Kuparuk areas directly has affected about 9,500 acres because of gravel excavation and filling and indirectly affects many adjacent acres of vegetation. The total affected acreage is a small part of the Arctic Coastal Plain (ACP), and cumulative effects probably are not significant to the overall productivity of tundra plants in this area. The effect of onshore-facilities siting—dust fallout, thermokarst, and hydrologic change—for future projects on bird populations, although additive, would be significantly less severe because they would be restricted to much smaller areas and result in smaller habitat loss. Pads, gravel quarries, pipelines, pump stations, and gravel roads that cross much of the CAH's calving range actually have destroyed only about 3-4% of the tundra grazing habitat for caribou (USDOI, MMS, 2007d; USDOI, BLM, 2005, 2004).

The continual loss of subsistence resource habitat associated with oil and gas development on the North Slope has been documented (Walker et al. 1987; Walker and Walker 1991). The Walker et al. (1987) geobotanical mapping study concluded that by 1986, the Prudhoe Bay Oilfield occupied approximately 500 km² between the Kuparuk and Sagavanirktok rivers, which included 359 km of roads, 21 km² of tundra covered by gravel, and 14 km² of area flooded because of road and gravel-pad construction. Expansion of disturbed areas since 1968 has been continual, although at a reduced rate. The study considered these to be major landscape impacts, and recommended that implications to wetland values, wildlife corridors, and caribou calving grounds be addressed (USDOI, BLM, 2004).

Development of all types has directly impacted approximately 17,770 acres (including all oil and gas activities and the portion of the Dalton Highway on the North Slope). Of this, approximately 9,640 acres are impacted from exploration and production facilities (pads, roads, airstrips, etc.). The second largest disturbed area is for gravel mines, which cover 6,365 acres (including both tundra and riverbed mines). The total affected acreage is a small part of the ACP. Recent, current, and expected future developments, such as Alpine, Badami, and Northstar, have and will continue to use technology advancements that require a much smaller acreage footprint than past projects on the North Slope (USDOI, BLM, 2004).

An increase in abundance of deciduous shrubs (less favorable caribou forage), especially birch, and a decline in the abundance of grasses/sedges such as *Eriophorum vaginatum* (an especially important food of calving caribou) would be predicted if a significant increase in average temperature were to occur in the Arctic, an effect that could reduce the productivity of caribou habitats on the Arctic Slope (Anderson and Weller 1996). Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals and some bird species, thereby adversely affecting their populations and subsistence uses (Anderson and Weller 1996; USDOI, BLM, 2004).

If roads on the North Slope are opened to the public, there would be an increase in access to caribou herds, muskoxen, grizzly bears, and other terrestrial mammals, potentially leading to more hunting and disturbance. Increased access increases competition for resources, a potential negative impact on subsistence hunters. Furthermore, more roads usually mean reduced access (or increased effort) for subsistence hunters. New roads are obstacles to traveling to traditional hunting areas because of security protocols imposed on access roads to and in development areas. Roads and pipelines force hunters to travel farther to hunt or force them to hunt in nontraditional areas (USDOI, MMS, 2007d; USDOI, BLM, 2005).

Offshore production-platform construction, trench dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 km for <1 year or season. These activities also temporarily may affect the availability of some local food sources for these species up to 1-3 km (0.62-1.9 mi) distance during island construction, but these activities are not expected to affect food availability for seals over the long term (USDOI, MMS, 2007d; USDOI, BLM, 2005).

Development on the scale of Prudhoe Bay in the Chukchi Sea region has not occurred and consequent habitat destruction presently is not an issue, except possibly in the vicinity of the Red Dog Mine near Kivalina and chronic habitat contamination from industrial pollution in many coastal areas on the Russia Chukotka coast (USDOJ, MMS, 2003a, 2007d; Berger, 1988; Chance and Andreeva, 1995).

4.4.1.12.4.9. Anticipated Effects From Onshore Development. The potential effects to subsistence-harvest patterns from onshore development were described in Sections 4.4.1.12.1.7.

Cumulative Past and Present Actions. Activities associated with exploration, facility construction, operation and maintenance, and oil spills have both disturbance and habitat impacts on terrestrial mammals and freshwater fish. Direct effects include delay or deflection of resource populations' movements and mortality; indirect effects include destruction or degradation of habitat and changes in productivity. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, changes when onshore oil development reduces the availability of resources or alters their distribution patterns. Regional exploration and development could affect subsistence resources because of potential oil spill, noise and traffic disturbance, or disturbance impacts from construction activities associated with ice roads, pipelines, and landfalls. Noise and traffic disturbance might come from building, installing, and operating production facilities and from supply efforts. Because little baseline biological, habitat, or subsistence-harvest data has preceded oil development on the North Slope, it is difficult to disassociate the cumulative effects of oil development in the region from the relatively recent processes of extreme local social change.

The effect of onshore-facilities siting—dust fallout, thermokarst, and hydrologic change—for future projects on bird populations, although additive, would be significantly less severe, because they would be restricted to much smaller areas and result in smaller habitat loss. Pads, gravel quarries, pipelines, pump stations, and gravel roads that cross much of the CAH's calving range actually have destroyed only about 3-4% of the tundra grazing habitat for caribou (USDOJ, MMS, 2003a).

Terrestrial mammals that would be affected by cumulative onshore development include caribou, muskoxen, grizzly bears, and arctic foxes. Oil development in the Prudhoe Bay area would continue to displace some caribou during the calving season within about 2.5 mi from roads with vehicle traffic that crosses calving habitat. The general shift of caribou calving away from the large oil fields may persist. Cows and calves of the CAH, over time, may reduce calving and the use of summer habitats near roads with high levels of traffic. If they do, these activities potentially could affect the caribou's productivity and abundance over the long term. However, this potential effect may not be measurable, because the caribou's productivity greatly varies under natural conditions. Some oil-development projects, such as Badami, do not include roads constructed to Prudhoe Bay and the Dalton Highway.

A number of large-scale developments are being considered for northwest Alaska. Potential impacts of individual projects on terrestrial animals should not be evaluated in isolation. Instead, the cumulative effects of all existing and proposed development should be considered collectively over the short and long term to predict impacts on animals. Because no large-scale, long-term monitoring system has been established on the North Slope, information gaps make it hard to assess the full extent of cumulative effects. A major concern regarding land management in the western Arctic is that the same pattern of incremental, piecemeal development that has occurred in the central Arctic will be repeated as industry moves westward. In the absence of a comprehensive conservation strategy, expanding industrial development over the next 25-50 years may have significant impacts on individual animal populations, subsistence use opportunities, and the integrity of the greater ecosystem. The Western Arctic Caribou herd (WAH) can be considered a "keystone" population, in that it provides critical resources for many other species sharing the ecosystem and is an important subsistence resource for as many as 40 Native

villages within the herd's annual range (Schoen and Senner, 2003). Therefore, careful consideration must be given to the impact of potential developments to this herd. Cumulative impacts to caribou could be reduced by not allowing leasing in the most sensitive areas; by consolidating facilities (especially reducing the number of roads); by reducing the footprint of development; by prohibiting roads between fields; and by restricting surface and air traffic, humans on foot, and other activities during the calving season. Cumulative oil development is likely to have only local effects on the distribution and abundance of caribou, muskoxen, grizzly bears, and arctic foxes on the North Slope of Alaska and not affect overall distribution and abundance (USDOI, MMS, 2003a; USDOI, BLM, 2004).

The alteration of more than 8,000 acres of tundra habitat in the Prudhoe Bay area has not had any apparent effect on the distribution and abundance of other terrestrial mammals, with the possible exception of arctic foxes that apparently have increased near the oil fields. Muskoxen have continued to expand their range westward across the North Slope from an introduced population in the Arctic National Wildlife Refuge (ANWR). There are no apparent effects on grizzly bears, wolves, and other terrestrial mammal populations associated with development.

Wide-ranging increases in impacts to arctic fish populations found on the North Slope would not be anticipated. Disturbance could cause some small loss of productivity and lowered fitness or survival of birds occupying areas with high levels of industry activity, but these effects would not be expected to be significant (USDOI, BLM and MMS, 2003; USDOI, BLM, 2004).

There is great concern among Inupiat that subsistence and cultural sites could be damaged because of such a sweeping undertaking as a road. In BLM's 1979 Section 105 (c) study of NPR-A, the Inupiat Community of the Arctic Slope stated in *The Inupiat View*:

Areas identified in the TLUI (Traditional Land Use Inventory) as critical to subsistence or cultural sites should be off limits to any oil and gas exploration and development activities, including transportation systems. Activities proposed outside these sites should be evaluated on a case-by-case basis in close cooperation with local residents and representatives of the Borough and ICAS; for in order to mitigate the effects of such disruption and alien uses, in a special environment of great significance to many people, requires special knowledge that only we can provide. (USDOI, BLM, 1979b)

In Hall's 1983 subsistence study for the proposed Brontosaurus exploratory well in NPR-A, many Inupiat were interviewed about their concerns regarding potential impacts from the project. Overwhelmingly, the most threatening factor was the potential contamination of the local watershed and subsequent impacts on local fisheries in the Inaru River drainage. According to Hall, one subsistence hunter felt that the Inaru basin was "akin to the ocean, being an extreme example of a wetlands and providing a feeding ground for the Inupiat." Those interviewed believed that "White scientists" were ignorant about the entire Inaru drainage, "particularly in terms of the nature and intensity of water movement and sediment transport." According to local residents, the watershed is a complicated web of lakes north and south of Niklavik Creek and the Inaru River connected by small streams that could be navigated by fish at high water. They believed that contamination of any single waterbody "whether directly or indirectly by run-off from the land" ultimately would affect any part of the downstream drainage. In addition, ice jams on the Meade River delta could cause water to flood back up the Inaru as far as Niklavik Creek, effectively bringing any contaminants upstream from their origin. To local Inupiat, the Inaru drainage was a unique yet susceptible aquatic resource. Flossie Itta stressed this point in an interview by Hall when she spoke of her grandparents warning her as a child to not even dispose of soapy wash water in local waterbodies because it could harm or frighten fish (Hall, 1983). These observations suggest that local subsistence-based communities would have major concerns with a potential permanent road between development sites in the northeastern portion of the Northwest NPR-A Planning Area. This road could compound runoff

impacts over a much more widespread area, potentially affecting lakes, streams, and major rivers and threatening local subsistence fisheries (USDOJ, BLM and MMS, 2003).

As part of the fieldwork protocol for a 1984 MMS technical report entitled *Barrow Arch Socioeconomic and Sociocultural Description*, researchers asked people in various Chukchi Sea villages their opinions on building land links between local communities and other regions of the North Slope. The majority of the people interviewed opposed land links to villages because (1) they appreciated the quality of life afforded them by semi-isolation, (2) they believed that roads would have a negative impact on wildlife resources, and (3) they worried that road access would increase liquor imports into “dry” villages (ACI, Courtnage, Braund, 1984).

Walker et al., in their 1987 paper *Cumulative Impacts of Oil Fields on Northern Alaska Landscapes*, found: (1) major landscape impacts from Prudhoe Bay development; (2) that indirect impacts such as thermokarst may not develop until many years after initial development; and (3) that the total area covered by direct and indirect impacts can greatly exceed the area of planned development. According to Walker et al. (1987): “There is a need to develop methods to assess cumulative impact and to foster comprehensive regional planning to anticipate the large impacts that are likely to occur on the coastal plain in the next few years.” A permanent road certainly would represent one of these “large” impacts, and would call for a massive planning effort accompanied by the gathering of all necessary baseline data along any potential route (Walker et al., 1987; USDOJ, FWS, 2001a).

In a 1987 FWS study that compared the actual and predicted impacts of TAPS, researchers concluded that:

Fish and wildlife habitat losses resulting from construction and operation of the Pipeline System and Prudhoe Bay oilfields were greatly underestimated in the [USDOJ's 1972 Final] EIS [on the Trans-Alaska Pipeline]. They included the direct losses of 22,000 acres from gravel fill and excavation, the even greater indirect losses of habitat quality due to the secondary impacts of construction (dust, siltation, erosion, impoundments, contaminants, etc.), and the blockage of fish and wildlife access to habitat by roads, pipelines, and causeways. Some of these indirect impacts were not predicted in the EIS, and the observed magnitude of frequency of others were greater than expected. Although some effort has been made to reduce habitat loss (through siting, consolidation of facilities, culverting, etc.) rehabilitation efforts along the Pipeline System have resulted in little restoration of habitat values...a lack of predictive capability may be expected whenever development moves into new geographical areas. (USDOJ, FWS, 1987)

Potential permafrost loss and hydrological changes related to global climate change could compound impacts from road construction and maintenance. The thawing of permafrost and associated increased maintenance costs already have become problems in arctic and subarctic areas (www.grida.no/climate/ipcc/regional, 2002).

The route of a permanent road connecting potential development sites in the northeastern portion of the Northwest NPR-A Planning Area to Barrow, Cape Simpson, or Nuiqsut would pass through important subsistence-resource habitat and important subsistence-harvest areas for caribou, fish, and birds. A road, combined with any development pipelines, would disrupt and displace caribou along its length and potentially disrupt hunting patterns by producing major alterations in hunter (including nonsubsistence hunter) access patterns in both summer and winter. Any road access would represent a major arterial where only trails had existed before. A road would promote the development and expansion of the oil patch, bringing with it similar issues about hunter access restrictions, hunting area reductions, trespass issues, disturbance and displacement of game, and the effectiveness of mitigation—all persistent and unresolved concerns from ongoing expansion at Prudhoe Bay, Kuparuk, and Alpine. The Dalton

Highway, paralleling much of the Arctic portion of the TAPS, has provided human access into remote regions and increased hunting and off-road vehicle impacts and accompanying impacts on caribou (Bergerud, Jakimchuk, and Carruthers, 1984; Spellerberg, 1998; Ricketts et al., 1999).

A 1997 study on the proposed Eureka to Rampart road assessed impacts to subsistence resources and activities by nonlocal residents as a result of increased access from existing road projects. Effects identified in the study communities of Rampart, Stephens Village, Tanana, Eureka, Minto, and Manley Hot Springs included: (1) increased nonlocal hunter use as a result of local access using the Dalton Highway; (2) increased nonlocal pressure on the hunting of moose, bear, and waterfowl, fishing for salmon, pike, whitefish, and blackfish, and trapping; (3) increased noise activity from nonlocal hunter boat use; (4) increased minerals development; (5) State land disposals increasing homesite developments and increased populations of potential subsistence users; (6) loss of habitat for subsistence resources and loss of lands used for subsistence harvests; (7) declines in moose populations; and (8) illegal use of Native lands by nonlocal users. As a result of this increased nonlocal access and hunting pressure, many local hunters curtailed their fall moose hunt and often waited until the winter season to hunt (Betts, 1997). Similar hunting, access, and habitat pressures on subsistence resources and harvest activities could be expected from potential State or NPR-A road developments on the North Slope. In general, caribou, fish, birds, and other terrestrial mammals would be expected to experience greater and more continuous disturbance and contamination effects from a road, with those nearest the road experiencing the greatest local disturbance and displacement. In the absence of restrictive regulations, local nonoil- and gas related activities—including inevitable nonsubsistence hunting (and the eventual pressure for increased sport hunting)—would be expected to have adverse effects on subsistence resource populations and subsistence-harvest patterns.

A 175-mi-long road across the NPR-A would produce more regional (thus, more profound) effects on the habitat and movement of subsistence resources and on hunter access. Bridging the many productive rivers from Nuiqsut west would make these watercourses more vulnerable to siltation and fuel-spill contamination. Of primary concern would be: (1) the lack of any reliable process for assessing and monitoring changes to subsistence-harvest patterns; (2) changes to hunter access; and (3) enforcement of the regulations that would need to be enacted to mitigate the profound and widespread effects such an artery would bring with it (Haynes and Pedersen, 1989).

If roads on the North Slope are opened to the public, there would be an increase in access to caribou herds, muskoxen, grizzly bears, and other terrestrial mammals, potentially leading to more hunting and disturbance. Increased access increases competition for resources—a potential negative impact on subsistence hunters. In addition, new roads often mean reduced access (or increased effort) for subsistence hunters. New roads are obstacles to traveling to traditional hunting areas because of security protocols imposed on access roads to and in development areas. Roads and pipelines force hunters to travel farther to hunt or force them to hunt in nontraditional areas (USDOJ, MMS, 2003a).

Development of regional roads within the planning area would have the potential to negatively affect wildlife and, thus, affect subsistence. These impacts would include habitat fragmentation, increased access into wildlife habitats, increased disturbance impacts, increased potential for mortality (road kills), and possible alteration of behavior or movement patterns of wildlife. If proposed road(s) linked small or regional communities to the already existent road system within Alaska, then increased competition for subsistence resource likely would result, as nonlocal hunters would be able to access the area with little effort. This also may result in an increase in tourist traffic and recreational use of the area, causing additional impacts to wildlife. Small roads that connect communities within the planning area might aid subsistence users in accessing their traditional harvest areas. However, they also might concentrate hunting efforts along the road corridor, thus depleting resources from the area and potentially altering harvest from currently used traditional harvest areas (USDOJ, BLM, 2006).

Any local or more extensive interconnecting road system could bring impacts from increased access to subsistence resources. More specifically, increased access could increase hunting pressure and increase competition for subsistence resources from both subsistence and nonsubsistence hunters. Increased harvest levels potentially could make game scarcer near the road proper. Reduced abundance and distribution of caribou and other terrestrial mammals would be expected along the road corridor from hunting, trapping, recreation, and tourist traffic associated with an interconnecting road. Increased hunting pressure in areas of high goose concentration could lead to declines in bird use of these areas. As a result of increased hunting pressure and reduced abundance, hunts could take longer as hunters would have to travel farther from the road corridor to successfully reach game or be forced to hunt in nontraditional areas. On the other hand, access could be diminished for subsistence hunters if the same problems were to arise in unitized oil fields where subsistence access has been curtailed near development sites by enforced no-fire zones (Chance and Andreeva, 1995; USDO, BLM, 2004; USDO, FWS, 2001a).

Traditional knowledge, as related by some hunters in northwestern Alaska, affirms that construction and operation of the Portsite for the Red Dog Mine has affected the subsistence harvest of belugas in the Chukchi Sea around the Portsite. The total harvest of beluga whales by hunters from Kivalina dropped off between 1984 and 1987, before construction began at the Portsite and has continued to be relatively low. In other marine waters of Alaska, belugas have tended to adapt to industrial and transportation noises after they have learned such noises do not represent a direct threat (Huntington and Mymrin 1996). Reports by Kivalina hunters indicate that either belugas of both spring and summer stocks have not yet become acclimated to structures or activities at the Red Dog Portsite or that other factors have reduced Kivalina's beluga harvest since construction began in the late 1980s. While data from the Beaufort Sea and Cook Inlet indicate that the presence and operation of marine transportation facilities have not caused long-term avoidance by belugas, the Kivalina combined spring and summer subsistence harvest declined about the time the facilities were constructed, and they have remained below preconstruction levels in most years since then. Other factors figuring into the decline of the beluga hunt could include long-term changes in ice conditions, beluga mass mortality reported in Siberian waters, and changes in beluga response to increased noise and activity (U.S. Army Corps of Engineers, 2005; Huntington, 1999).

4.4.1.12.4.10. Anticipated Effects From Production Activities. The potential effects to subsistence-harvest patterns from production activity were described in Section 4.4.1.12.1.8.

Cumulative Past and Present Actions. Cumulative development of oil and gas production facilities on the North Slope may affect subsistence-harvest patterns of North Slope Inupiat communities. Current development in and adjacent to the Prudhoe Bay and Kuparuk oilfields primarily is to the east of North Slope communities and their associated subsistence areas, although the subsistence use area of Nuiqsut does extend into areas of existing development. Future lease sales and projected development in the NPR-A could extend development to the west into subsistence-use areas of the communities of Barrow, Wainwright, Point Lay, and Atqasuk. Because little baseline biological, habitat, or subsistence-harvest data have preceded oil development on the North Slope, it is difficult to disassociate the cumulative effects of oil development in the region from the relatively recent processes of significant local social change (See the Onshore Development discussion above) (USDO, BLM, 2004).

Cumulative impacts from underwater industrial noise, including drilling noise measured from artificial gravel islands, has not been audible in the water more than a few kilometers away. Because the beluga whale migration corridor is far offshore of the barrier islands, drilling and other development and production noise in the nearshore area likely would not reach many migrating beluga or gray whales. Noise also would be unlikely to affect the few whales that could be in lagoon entrances or inside the barrier islands because of the rapid attenuation of industrial sounds in a shallow-water environment.

Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it would not be likely to affect beluga or gray whales. The cumulative effect of disturbance to bird and fish resources due to seafloor sampling and drilling platforms probably would be minor, due to displacement from surface areas, such as Ledyard Bay (USDOI, BLM and MMS, 2003; USDOI, MMS, 2007d).

4.4.1.12.4.11. Anticipated Effects From Climate Change. The potential effects to subsistence-harvest patterns from climate change were described in Section 4.4.1.12.1.9.

Cumulative Past and Present Actions. A factor of increasing concern is the potential for adverse effects on subsistence-harvest patterns and subsistence resources from global climate change. The Council on Environmental Quality (CEQ) bases its guidance on the National Environmental Policy Act (NEPA) regulations, which mandate that all “reasonably foreseeable” environmental impacts of a proposed Federal action must be considered in the NEPA assessment. The CEQ considers that there is adequate scientific evidence (e.g., in the *Second Assessment Report* by the Intergovernmental Panel on Climate Change [IPCC]) indicating that climate change is a “reasonably foreseeable” impact of greenhouse gas emissions (CEQ, 1997; IPCC, 2001; USDOI, MMS, 2006b).

Because of the growing body of evidence that shows that climate change is occurring and this CEQ guidance, we have included it as an impact factor in the cumulative analysis of subsistence resources and practices. This resource includes climate change as a cumulative impact factor because it meets one or both of the following two criteria: (1) The resource already is experiencing impacts from climate change, so the effects are observable and not speculative (see Traditional Knowledge section below). In Alaska, for example, the effects of climate change in recent decades have resulted in decreased extent and thickness of sea ice and other changes that could impact biological resources and subsistence harvest-patterns. (2) The resource will be directly affected by warming temperatures. An example of direct impacts of warming is increased melting of continental ice that leads to accelerated sea level rise and erosion and inundation of coastal wetlands (USDOI, MMS, 2007c).

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic significantly could affect subsistence harvests and uses if warming trends continue (NRC 2003a, ACIA 2004). Every community in the Arctic potentially is affected by the anticipated climactic shift, and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope. If the loss of permafrost, and conditions beneficial to the maintenance of permafrost, arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of freshwater, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC 2003a, ACIA 2004; USDOI, BLM, 2005; USDOI, MMS, 2006b).

Permafrost thawing is expected to continue to damage roads and buildings and contribute to eroding coastlines and increase building and maintenance costs. The cost of shifting buildings, broken sewer lines, buckled roads, and damaged bridges already causes an estimated \$35 million worth of damage in Alaska annually. Sea level rise and flooding threaten buildings, roads, and power lines along low coastlines in the Arctic and, combined with thawing permafrost, can cause serious erosion. In Kotzebue, the local hospital had to be relocated because it was sinking into the ground (ARCUS, 1997). Kaktovik’s 50-year-old airstrip has begun to flood because of higher seas and may need to be moved inland (Kristof, 2003). Shore erosion in Shishmaref, Kivalina, Wainwright, and Barrow in Alaska and Tuktoyaktuk at the

mouth of the Mackenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline. Eventually, some of these communities will be forced to relocate (USDOJ, MMS, 2006b).

Erosion of river banks and beach bluffs, resulting from the thawing of permanently frozen ground, could have severe effects on how subsistence practices are undertaken, as subterranean ice cellars for storing food harvested at remote places for later transportation to the village could collapse and cabins and camps could continue to be washed away. Erosion and climate changes could change water levels in rivers and streams, making transportation by boat and land more difficult, damaging or destroying infrastructure, and reducing water quality (e.g., turbidity, dissolved oxygen) until some waters are no longer suitable fish habitat (USDOJ, BLM, 2005).

The duration of ice-road usefulness in the Arctic already has diminished and has led to an increased need for more permanent gravel roads. However, gravel roads are more prone to the effects of permafrost degradation, thermoclast, and consequent settling that increases maintenance costs (Nelson, 2003b,c). Gravel roads also contribute to the fragmentation of landscapes and habitats that through time can lead to reduced species' productivity. Such an impact on species is a threat to subsistence livelihoods (USDOJ, MMS, 2006b).

Waterflows would increase as glacier-fed streams absorbed melting runoff and decline as the glaciers retreated, also changing water quality, fish habitat, and possibly damaging the river valley microhabitats along the north-south oriented rivers of the North Slope. Climate changes could reduce suitable browse for caribou and muskoxen, possibly shifting their range away from the communities or reducing their numbers. The same habitat changes may favor moose, which Inupiat hunters perceive as less suitable as a subsistence staple because moose are solitary, require large ranges per animal, and do not predictably move in large numbers to specific areas, making it more difficult and energy intensive to harvest them. Due to their size, moose also require more effort to butcher, transport, and process than caribou and muskox (ACIA, 2004). Climate change could result in a reduction in marine ice and a less safe ice edge, affecting spring marine mammal hunting, including Barrow spring bowhead whale hunting, polar bear hunting, and seal hunting (USDOJ, BLM, 2005).

Marine currents could be changed by the retreat or disappearance of the ice sheet, shifting some marine mammals much further offshore or to where the habitat is still available, perhaps as far as High Arctic Canada. Migratory waterfowl numbers could decrease, change their migration paths, or go extinct if key habitat were changed. Marine currents could change the distribution and habitats of anadromous and amphidromous fish, which are key subsistence resources for the communities. Warmer temperatures also could reduce habitat for freshwater fish, or change populations to those more suited to warmer waters. Rising sea levels could inundate low-lying coastal lands along the North Slope and change the salinity of surface and groundwater, further changing fish and waterfowl habitats and subsistence resource uses (USDOJ, BLM, 2005).

Continuing sea-ice melting and permafrost thawing could threaten subsistence livelihoods. Typically, peoples of the Arctic have settled in particular locations because of their proximity to important subsistence-food resources and dependable sources of water, shelter, and fuel. Northern peoples and subsistence practices will be stressed to the extent that settlements are threatened by sea-ice melt, permafrost loss, and sea level rise; traditional hunting locations are altered; subsistence travel and access difficulties increase; and game patterns shift and their seasonal availability changes (USDOJ, MMS, 2006b). As the landscape becomes less hospitable for human occupation, people could move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. As a result, community stresses would increase and traditional knowledge

of the landscape, environment, and resources would be devalued, particularly local conditions changed rapidly. Reduced levels of stratospheric ozone could increase levels of UV exposure to northern peoples, lowering immune-system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA 2004; USDOJ, BLM, 2005).

Overall, large changes or displacements of resources are likely, leaving little option for subsistence communities: they must quickly adapt or move (Langdon, 1995; Callaway, 1995; *New Scientist*, 2002; Parson et al., 2001; AMAP, 1997; *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird-breeding and -molting areas, affect the distribution and abundance of anadromous and freshwater fishes, and limit or alter subsistence access routes (particularly in spring and fall) (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal migration routes and this, in turn, would impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001; USDOJ, MMS, 2006b).

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna still could be significant; but at the same time, these impacts “cannot be reliably forecast or evaluated” and “...positive effects such as [1] extended feeding areas and seasons in higher latitudes, [2] more productive high latitudes, and [3] lower winter mortality may be offset by negative factors that alter established reproductive patterns, breeding habitats, disease vectors, migration routes, and ecosystem relationships” (IPCC, 2001; USDOJ, MMS, 2006b).

Climate change impacts on Alaska’s North Slope have become a growing concern among the coastal subsistence-based communities there. During the 2005 NSB mayoral election, the winning candidate, Edward Itta, identified climate change as the biggest threat to subsistence:

Recent changes in the climate have the ice moving greater distances from shore. This not only means that hunters and whalers have to go out farther and use more fuel, it’s becoming more dangerous.... The window of opportunity for seal hunting and whaling is getting shorter and shorter. (Stapleton, 2005)

Walrus, ringed seals, other ice-dependent pinnipeds, and polar bears have been identified as being particularly vulnerable to the impacts of continued climate change; the potential cumulative effects on them are a primary concern and warrant continued close attention and effective mitigation practices. The main effects of concern to polar bears are climate change, potential overharvest in the Russian Arctic, and oil and fuel spills (USDOJ, MMS, 2003a; USDOJ, MMS, 2007d).

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet could be expected. Increased climate changes are likely to continue to affect subsistence activities; additional losses of traditional subsistence harvest areas would occur, and traditional subsistence resources might no longer be available for harvest (e.g., some species of migratory birds). Subsistence users would continue to travel farther to harvest resources but are unlikely to cease subsistence harvests, given the strong cultural continuity and value of subsistence activities (Johannessen, Shalina, and Miles, 1999; IPCC, 2001b; NRC, 2003a; NMFS, 2008b; USDOJ, BLM, 2005).

4.4.1.12.5. Traditional Knowledge on Cumulative Effects. Traditional knowledge from potential effects on subsistence-harvest patterns appear in Section 4.4.1.12.3.

Cumulative effects from oil development have been, and continue to be, paramount concerns for North Slope residents. Anxiety about the possibility of nearshore and offshore oil exploration and development activity is itself an accumulating effect (NRC, 2003b:148). Nearshore and offshore development, which the Inupiat have long feared and opposed, is again being proposed for the Beaufort and Chukchi seas (Ruskin, 2004), and such nearshore and offshore development are considered to be potentially catastrophic to subsistence users in the NSB whaling communities (Kruse et al., 1983a,b; Impact Assessment, Inc., 1990a, Pedersen et al. 2000, NRC 2003a). Nuiqsut elder, Noah Itta, expressed this concern at the recent hearings held there for the Liberty Development and Production Plan:

He sure hates to see some drilling being done in the ocean right now, and he hates for the mammals to be disturbed because they live off of them from generation to generation. And then he opposes drilling down in the ocean while there is oil on land. He very much opposes it. He's not happy with it. Like the rest of these people here, they're not happy with it. They go far down there to—you know, way far from their home to catch the whale, and then how far would they have to go if they—you know, if the whales are disturbed from the drilling right now? How far do they have to go get the whale? That's what he's worried about. (Itta 2001, USDO, MMS, 2001; USDO, BLM, 2004).

Public testimonies that contain a wealth of traditional knowledge are found in public hearings for MMS Beaufort and Chukchi seas lease sales at:

<http://www.mms.gov/alaska/ref/publichearingsChukchi/PublicHearings.htm> and at <http://www.mms.gov/alaska/ref/PublicHearingsArctic/PublicHearings.htm>

These files contain 25 years of public testimony related to activities on the OCS, as well as onshore. These sites are incorporated by reference and the quoted passages below come from these two sources. For another valuable summary of North Slope testimony on North Slope oil development activities see the Native Voices section to Miller, Smith, and Miller (1993; USDO, MMS, 2007d).

Kaktovik resident Michael Jeffrey, testifying at the first MMS lease sale for offshore oil and gas, saw a social impact from government actions. He said there was a cumulative effect on the villagers from having to participate in hearings and meetings. People knew the issues were important, so they had to take time off from working and hunting to attend. Jeffrey believed assessment documents were too technical. To help villagers with them, he suggested extending deadlines in communities that do not speak English so there would be enough time for agencies to translate documents (Jeffrey, 1979, as cited in USDO, BLM, 1978b; USDO, MMS, 2003a; 2007d).

The NSB sent written scoping comments and recommendations on the BLM's Northeast NPR-A IAP EIS in April 1997. Their comments articulated concerns about potential effects to subsistence hunting and:

...about the cumulative impacts of all industrial and human activities on the North Slope and its residents. Consideration of these impacts must take into account industrial activities occurring offshore and at existing oil fields to the east; scientific research efforts; sport hunting and recreational uses of lands; and the enforcement of regulations governing the harvest of fish and wildlife resources by local residents. To date, no agency has addressed the concerns of Borough residents over how cumulative impacts might affect life on the North Slope. (NSB, 1997; USDO, MMS, 2003a; 2007d)

Former Barrow Mayor Ben Nageak spoke at public hearings for the NPR-A Integrated Activity Plan(IAP)/EIS in Barrow in January 1997. He said one of the key issues in developing the Reserve would be to identify “a mechanism for recognizing and mitigating the potential cumulative impacts of multiple industrial operations” (Nageak, as cited in USDO, BLM and MMS, 1998:Section IV. C. 6. Vegetation b. Development (2) Effects of Spills). At a Liberty Development Project information update meeting in November 1999, Ron Brower, head of the Inupiat Heritage Center in Barrow, asked about future leasing and development plans and noted that MMS seemed to be doing projects piece by piece when instead it should be studying cumulative impacts. He believed new data and new development projections were needed and wanted to see a “new blueprint [for development] from aerial flights to underwater impacts” (Brower, as cited in USDO, MMS, 1998a). At the same meeting, Maggie Ahmaogak, Executive Director of the AEW, asked that MMS take into account cumulative risks (USDO, MMS, 2003a; 2007d).

Slopewide, the issue of BLM’s failure to resolve local allotment claims remains a serious long-term concern. There also are concerns about past contamination and potential new contamination of watersheds from oil exploration (Leavitt, 1980; Aiken, 1997; (USDO, BLM and MMS, 1998, 2003; USDO, BLM, 2004, 2005; Sale 193).

The Inupiat people of Nuiqsut have expressed concern about the cumulative effects of petroleum exploration and development on subsistence resource harvesting since the Prudhoe Bay was first developed (UAA, ISER 1983). These concerns include access to desired use areas and resources, changes in the quality and availability of subsistence resources for harvest, the perception that subsistence resources could be tainted by pollution, and changes to the character (e.g., solitude and remoteness) of areas used for subsistence harvests caused by industrial occupation and activity. These concerns have been articulated by local residents since the resettlement of Nuiqsut and were expressed by the late Thomas Napageak, former Nuiqsut Native Village President and Chairman of the AEW in his 1979 scoping testimony for Sale BF:

The Draft Environmental Impact Statement makes assumptions that we are moving away from our subsistence into a cash economy.... I would like to point out to you that maybe that is the desire of the government, but it is not ours. We, here in Nuiqsut, by our own personal choice, left homes and jobs in Barrow to return to our ancestral lands to live in tents like our grandparents and to live off the land. We re-established the area that has always been used by our people. The land and coastal region provides us with subsistence, which is the foundation of our culture. We cannot live without our Native food, nor would we want to if we could. (Napageak, as cited in USDO, BLM, 1979; 2004).

The key elements of subsistence access include the ability to get to favored subsistence-harvest locations to harvest particular species when they are available in that area, at times when there are particularly favorable seasonal aspects to the resources. Caribou, for example, are hunted for general consumption in July and August, but they are the fattest and most desirable in October (S.R. Braund and Assocs., 2003). Social rules may affect access, such as traditional or regulatory prohibitions against shooting near people, oil production facilities, and pipelines. As oil and gas infrastructure and permanent facilities are built in traditional subsistence-harvest areas, hunters tend to consider those areas off-limits to hunting (NRC, 2003a, Pedersen et al., 2000, Pedersen and Taalak, 2001). Areas of vital importance for all Nuiqsut subsistence users, including the Nigliq channel corridor from Nuiqsut to Fish Creek, are now in the vicinity of proposed onshore development (USDO, BLM, 2004).

Sam Taalak, Nuiqsut’s Mayor in 1982, saw the onslaught of cumulative activity 26 years ago: “We presently live at Nuiqsut and for the moment we’re hemmed in from all sides by major oil explorations, even from the coast front” (Taalak, 1983, as cited in USDO, MMS, 1983c). Fourteen years later,

Leonard Lampe, another former Mayor of Nuiqsut, noted that the village had begun to consider the long-term effect of oil development on their subsistence lifestyle and Inupiat culture: “It’s time to look at things seriously and ask if it’s worth it. That’s what the town is asking itself” (Lavrakas, 1996; USDOl, MMS, 2003a; 2007d).

Thomas Napageak clarified some of these concerns. In a January 10, 1997, meeting with MMS in Anchorage over a possible Nuiqsut Deferral for Lease Sale 170, Mr. Napageak explained that the people of Nuiqsut had begun to focus on cumulative effects because they were concerned that when the Northstar Project proceeded, it would be out there and affecting the community and its ability to harvest subsistence resources for 15-20 years. Such development directly affects Nuiqsut. Mr. Napageak wanted Sale 170 stipulations to deal with cumulative effects from the sale and from other projects, and clear language about cumulative effects in the EIS. He wanted to see protective language developed for leases in the Sale 170 area that would extend to and bind lessees with leases from past sales (Casey, 1997, pers. commun.; USDOl, MMS, 2003a; 2007d).

At a scoping meeting in Nuiqsut for the original 1998 Northeast NPR-A IAP/EIS, Mr. Napageak noted again the importance of assessing cumulative effects on subsistence resources and harvests, especially the cumulative and indirect effects of existing and potential oil development on Nuiqsut. He remarked: “Federal leasing cannot be examined in isolation as though none of this other development and potential development were going on” (USDOl, BLM, 1998a). At a BLM symposium on the NPR-A held later the same month, he reaffirmed this concern: “Accumulated impact effects that would hinder the community and the socioeconomics of the community, how it will be affected by Alpine and presumably by NPR-A, these...really need to be considered” (Napageak, as cited in USDOl, BLM, 1998b). At an information update meeting in November 1999 for the Liberty Development Project, elders Ruth Nukapigak and Marjorie Ahnupkana reaffirmed local concern for ongoing effects from oil development, saying that Eskimo traditions of long ago were going away with the oil companies coming in (Ahnupkana, as cited in USDOl, MMS, 1998a, 2003a; 2007d).

Other factors, such as the sights, smells, noise, light, and activity associated with oil and gas exploration and development, may reduce access. The current mayor of Nuiqsut, Rosemary Ahtuanguarak, notes these factors in the following statement:

Because of these oil and gas related events, Inupiat subsistence users do not hunt in areas where people, gasoline, and diesel fumes are present. Our hunters and trappers have been displaced from traditional trails, which have become harder and dangerous due to oil and gas activities and had to be redirected to avoid these traditional hunting areas. (Ahtuanguarak, as cited in USDOl, MMS, 1998; USDOl, BLM, 2004)

The existing effects of oil and gas activity have spread from Prudhoe Bay to an area encompassing the north and west approaches to Nuiqsut. Nuiqsut residents have been concerned for many years that the community would be surrounded by pipelines, pads, and roads, excluding them from important subsistence use areas (UAA, ISER 1983, Impact Assessment, Inc., 1990a, Pedersen et al. 2000, NRC 2003a). This concern has become more immediate with further development being proposed in their traditional subsistence-use areas. By 1990, the perception that access to subsistence use areas already was limited arose during scoping, as further restrictions became an issue of concern associated with future development, as noted in the following statement by Rev. Nelson Ahvakana from Nuiqsut:

Like a good example is Prudhoe Bay. They say that that area is open for subsistence, and it’s not. It’s written on paper that it is, but the actuality, you go and take a rifle over there, the first things – first thing that you’re going to find out is — is that the security’s going to take care of you. They’re not going to let you go anyplace, even though that you may say that I’m out here on

subsistence hunt. They don't have no concern whatsoever about that; their concern primarily is the protection of that field, and this is exactly what's going to happen down there. And our people here, they're, like I said, is surrounded [sic]. The only area, hunting area that we have during the summer is down there to the ocean and up the river. Now, you can go both ways because a person that's going to be getting food for the family for that day cannot get food for that day if he's walking. You try and walk and see how far you can go. (Ahvakana, 1990; USDOI, BLM, 2004)

The term, “availability” of subsistence resources includes aspects of access, as well as subsistence species behavior and biology. In strictly biological terms, “availability” has meant that population numbers of caribou are high enough to support a harvest without significantly reducing herd numbers when considered in conjunction with predator take, sports harvests, and other factors that would reduce the population. For subsistence, the number of a particular species is important as a basic attribute of availability. However, in some cases there may be suitable numbers of a species, but the species (resource) may change migration patterns, be diverted or occupy an area considered by hunters to be off-limits to harvest activities because of real or perceived regulation, contamination, or difficulties in physical access, rendering the resource inaccessible for the purposes of subsistence. In other cases, the animals may be present in their usual harvestable locations, but only while hunters are unable to hunt (e.g., conflicts with work schedules, poor travel conditions). Just such a conflict was expressed by Rosemary Ahtuanguak:

We have our first generations of people living in formally structured houses that require a new lifestyle of a cash economy to meet the costs of them. This restricts our harvest by not allowing us to follow the animals. We are facing many problems by this, for our men have been the providers of our families, and they must step between both worlds. They require the guns and the snowmachines to allow them to harvest in the narrow windows of time that exist due to commitment to work. They are torn by the traditional needs of providing from the land and the stresses of needing cash to purchase items that save on time. (Ahtuanguak, as cited in USDOI, MMS, 1998; USDOI, BLM, 2004)

A hunter from Nuiqsut commented on effects to the CAH: “The vibration of horizontal drilling bothers animals and makes them afraid. The migration route of the Central Arctic [caribou] herd changed because of this” (S.R. Braund and Assocs., 2003, as cited in USDOI, BLM, 2004; 2007d).

An aspect of oil and gas development that could divert or deflect terrestrial mammals is the growth of infrastructure into new areas, in particular roads, pipelines, airstrips, and gravel pads, and any local or more extensive interconnecting road system could bring impacts from increased access to subsistence resources. These structures interfere with the passage of hunters and their harvests and, as noted in NRC (2003a), gravel roads and pads are not likely to be removed once abandoned. Concern was expressed for the proposed Colville River Road interconnecting Nuiqsut and the NPR-A with the Dalton Highway (USDOI, BLM and MMS 2003; USDOI, BLM, 2004).

In a 40-page, March 2002 letter to the U.S. Army Corps of Engineers, Nuiqsut's Kuukpik Corporation, the Native Village of Nuiqsut, the City of Nuiqsut, and the Kuukpikmiut Subsistence Oversight Panel, voiced strong opposition to Phillips Alaska's proposed development of the Fjord and Nanuq satellite fields near the Alpine development project. They called for the Corps of Engineers to prepare an EIS to address the multitude of potential impacts they believed would occur from this expansion, particularly a proposed north-south connecting road in a development scenario that had been promoted as “roadless.” They also wanted the Corps and Phillips to address broken agreements and permitting lapses with Kuukpik over: (1) exceeding employment ceilings and aircraft flights at Alpine and winter drilling activity on the Colville Delta; (2) the proposed building of additional vertical support members (VSMs)

for satellite developments when existing VSMs were supposed to be adequate; (3) yet-to-be-delivered studies on caribou in the Colville River Delta and the Alpine Sociocultural Study report; and (4) poorly projected and analyzed drilling activity and pipeline impacts from the Tarn and Meltwater Projects. In its letter to the Corps of Engineers, Nuiqsut concluded: “In essence, this whole letter is about cumulatively significant impacts, ranging from the manner in which Alpine impacts have exceeded projections...” (Kuukpik Corporation et al., 2002).

North Slope Inupiat elder Frederick Tukle, Sr. expressed concerns about changes in caribou migration behavior he attributed to pipelines when he said:

If you—with these animals already being displaced, now it's starting to be from Cross Island to Teshekpuk that I've noticed these animals, over a period of time, going away. And then there—right now, we're having a real hard time 'cause of the pipelines from Oliktok to Kuparuk. There's a 13-mile pipeline that's about three-feet high that, itself, already has displaced our caribous in the village. We already had a hard time with the geese already going away from these facilities. I watched these firsthand over a 15-year period, and this is what got me to move from Nuiqsut to Barrow, is observing these oil activities that's occurring. In addition to this 13-mile pipeline I'm talking about, with the new discoveries that already occurred south of the Kuparuk field, we have about another over 10-mile pipeline again, that that's three feet high. And then you look at the caribous when they—when they're trying to get to the ocean side, they're always migrating, keeping away from these bugs and everything. They stop right at Oliktok. They—we don't see those anymore, these thousands of migrating caribous. Now, at the same time, we're seeing hundreds. (Tukle 2001 as cited in USDOJ, BLM, 2004; USDOJ, MMS, 2007d)

Another North Slope Inupiat expressed concerns about changes in caribou migration and behavior and noted that if the change in caribou group size is a persistent phenomenon, it could require increased time, fuel costs, wear and tear to hunters and equipment, and hunting effort on the part of hunters to harvest sufficient numbers of caribou during the summer insect relief period, effectively reducing the availability of the resource to subsistence users (USDOJ, BLM, 2004).

A similar concern for subsistence fishing was attributed to the construction of causeways at Oliktok and West Dock by Thomas Napageak in 1996: “But they used to be up, before these causeways, used to be plentiful. And then people just quit fishing when they have enough. Now you can have your net out there until you can't get anymore, and you still don't get enough supply for winter” (Napageak, 1996; USDOJ, BLM, 2004).

Subsistence fish-availability issues sometimes are associated with more difficult-to-pursue causes (e.g., global warming, upriver pollution, river crossings, pipeline vibration, water withdrawals, seismic testing). Because of the present lack of definitive answers regarding fish availability and resource health issues, some hunters have expressed concern that the NEPA process is not addressing some effects from oil and gas activities adequately. Concerns about subsistence resources and the future availability of those resources are perceived as threats to the continued existence of the Inupiat people and their way of life. Causes that are more concrete were expressed by Nuiqsut Mayor Leonard Lampe in 2002:

You know, things have been going on in this village for many years and none of you agencies have ever given us real reasons of why things are changing around us. Everybody tells us global warming. That's why things are happening in your village, that's why you're not getting your Cisco, that's why you're not getting your caribou migration regularly. Well, there's things that are happening that everyone else doesn't want to take responsibility for. Thousands of millions of gallons are extracted from lakes and ponds throughout the region. Maybe that's a reason why fish aren't coming here no more. Ice bridges that are built on rivers ground down to the bottom

of the rivers making ice walls, maybe that's why Ciscos aren't coming in. (Lampe 2002, 2002 Point Thomson Scoping Hearing, cited in USDOJ, BLM, 2005)

Contamination and the perception of contamination, of subsistence resources also may affect the use of subsistence foods through reduced or abandoned harvests, increased stress about the effects of consuming possibly tainted food, concerns about future availability of subsistence resources, and a decline in the satisfaction of eating subsistence resources. Responses to known pollution reflect the importance of subsistence foods even in the face of measurable contamination and, as one interviewee noted: "the ADF&G told us the burbot has mercury, pcbs in the liver, but I eat 'em anyway" (S.R. Braund and Assocs., 2003; USDOJ, BLM, 2004).

It is possible that local responses to concerns about contamination could resemble those noted for the EVOS (Fall et al., 2001; USDOJ, BLM, 2004), where concerns about contamination extend beyond the study of measurable pollutants to the perception that there are as-yet unknown or unmeasured levels of contaminants in the environment affecting both the Inupiat and the resources they harvest. Contaminants may be present in small quantities deemed harmless, but may accumulate and have serious, long-term, and ongoing health consequences yet unstudied, for both the Inupiat and the species they rely for subsistence (NRC 2003a). Behavioral responses to the perception of contamination are as real as responses to measurable pollution. The current Mayor of Nuiqsut, Rosemary Ahtuanguak, outlines stresses placed on resource users in response to real and perceived contamination:

There has been many problems with various developments. And there is by-products left all around, areas where you have worked and got your oil and it's left over. We go out and we travel around our land. We go hunting in this land. The by-products of these developments are definitely hurting us. We state that. But yet, in your book it says it's not to a level that's acknowledged as being harmful. Well, we are definitely being harmed by this development. (Ahtuanguak 1997; USDOJ, BLM, 2004).

In addition to concerns regarding access and contamination, some Inupiat have taken issue with the use of wilderness-designation programs to regulate land use, and in some cases have spent significant sums to counter designations that reduce their access to traditional subsistence use areas (Hall, Gerlach, and Blackman 1985). Recent proposed activities in the NPR-A have raised concerns that subsistence uses will be eliminated if nonproductive management regimes are applied, as this extract Nuiqsut resident, Bernice Kaigelak's testimony from 1998 outlines:

With these Alternatives of B, C, D and E, the reason why am I opposing them is what do I know about designating the Colville River, a wild and scenic river. Are they going to stipulate fishing regulations on it? How do I know it's not on the dotted line of your EIS draft there? What about this proposing of a bird conservation area? Is that going to limit me from hunting the geese and ducks that I do so freely? And the 50 percent of the area where it's covered, it's not even close to where we should be. I mean, where are we protected? (Kaigelak 1998, as cited in USDOJ, BLM, 2004;1998b, 2004)

The desire for a solitary experience in open, uncrowded country as a form of relaxation and renewal for Inupiat people is mentioned directly as a stress reliever but more often as part of the solitary hunt for furbearers. Many hunters discuss the enjoyment of covering vast areas with their snowmobiles and, in some cases, facing challenges and hardships during prolonged hunts for wolves and wolverines (S.R. Braund and Assocs., 2003). This solitary endeavor has a spiritual value to these hunters. Solitude and isolation also are mentioned in the context of offering privacy, a sometimes rare commodity in small communities:

I see that protective measures, exploratory drilling is not allowed within 1,200 feet of any cabin or known long-term campsite. To me I don't have any scientific data, but I know if we would have had a drilling rig within 1,200 feet of our honeymoon it sure wouldn't have been as great of an experience as it was. And I hope that my children can someday experience the solitude, the feeling of being out there on your own. (Vorderstrasse 1998, Jim Vorderstrasse, 1998, as cited in USDO, BLM, 2004a)

The 1997 NPR-A Subsistence Impact Analysis Workshop report outlines a similar array of ongoing local impacts related to subsistence use and land management in Nuiqsut's key use areas (USDO, BLM and MMS, 1997). Under the heading "Panel Discussions in Nuiqsut" are listed numerous issues, and the pertinent examples are listed below:

- They feel that 18 months is too short [to review NEPA undertakings].
- The community is tired of [attending] meetings and giving [the] same information.
- They feel frustration with increasing restriction on access.
- [There is a] Lack of human resource in community to analyze documents and represent local concerns. The NSB needs to provide assistance.
- They give a sense of being overwhelmed by external influences and events.
- Community feels it is a victim, not a participant. Over years, faces and names and proposals change, but [community] concerns aren't met. Need opportunity to participate in what goes on around them. [BLM] must set stage for that to happen. [The community] Need(s) to be able to influence planning process and continue [that influence] into leasing.
- People feel 90 percent of subsistence use is in Northeast Planning Area and want development left to occur outside this area.
- Government keeps coming back until community is worn down and gives up. Asked to trust government but they are seeing impacts the government/industry said wouldn't happen.
- Need to empower local subsistence advisory panel (Alpine EIS).

Comprehensive subsistence-harvest and -resource studies, monitoring, and stipulations are needed for assessing impacts on subsistence resources and hunter access to those resources. The innovative Subsistence Advisory Panel formed under the leasing effort for the Northeast NPR-A Planning Area is made up of BLM, State, and local community representatives and has held a number of meetings since 1999. The group investigates conflicts between subsistence hunters and oil exploration and development activities, verifies the level of conflict, and proposes actions to the lessee and BLM for resolution. It is this type of group that may resolve some of the ongoing monitoring, mitigation, and enforcement concerns with subsistence (USDO, BLM and MMS, 2003).

Without some mechanism to ensure subsistence hunters access to and through development areas and a protocol for defining "no-fire" zones around development sites, the overall ability to reach subsistence-harvest areas by local subsistence hunters potentially would be restricted. No ongoing monitoring efforts assessing subsistence-resource damage, resource displacement, changes in hunter access to resources, increased competition, contamination levels in subsistence resources, harvest reductions, increased hunter effort, increased hunter risk, and increased hunter costs have been established. Without a process in place for monitoring harvest patterns and the effectiveness of current mitigation measures, which necessarily would include serious attention to traditional Inupiat knowledge of subsistence resources and practices, no truly informed projection can be made about cumulative effects on subsistence on a systematic and regular basis. The need for an ongoing monitoring effort already has been demonstrated, as initial research has already shown that North Slope oil development has produced more regulation of local subsistence pursuits, reduced access to hunting and fishing areas, altered habitat, and intensified the competition by nonsubsistence hunters for fish and wildlife (Haynes and Pedersen, 1989; USDO, BLM and MMS, 2003).

Native bowhead and beluga whale hunters in the Chukchi Sea communities of Wainwright, Point Lay, and Point Hope maintain that they, too, will be affected by cumulative impacts. Anxiety about the possibility of ongoing and future nearshore and offshore oil exploration and development activity is in itself an accumulating effect (NRC, 2003a:148).

Perceived threats to subsistence may reinvigorate subsistence pursuits, as the formation of the AEW in response to proposed IWC regulation demonstrated (NRC 2003a). Harvest failures in the past have resulted in increased sharing of subsistence foods between communities and the hosting of hunters from communities experiencing a shortage at communities with relative abundance for that resource. Thus, concerns about nonpolluting cumulative effects on subsistence in the communities may reinforce and invigorate traditional responses to these effects, and as a result, renew the traditional relationships between subsistence users and their use of the environment. The cumulative effects of pollution, both local and global, will likely both reinforce and inhibit traditional subsistence practices (USDOI, BLM, 2004).

The disruption of bowhead whale harvests would result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals—making them more skittish, for example—in reaction to OCS and other past, present, and reasonably foreseeable activities. The greater the degree of activity onshore and on the OCS, as measured by increases in seismic noise, vessel traffic, east-to-west development, increased activity in the Chukchi and Beaufort seas, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. To a large extent, stipulations, required mitigation, and conflict avoidance agreements between subsistence whalers and oil operators have mitigated such potential effects and may continue to do so. Such activities are ongoing and cumulative, and potential onshore impacts on subsistence resources and harvests would be magnified by any possible expansion into the NPR-A northeast and northwest areas. As proposed development with long-term occupation and changes to the landscape take place, there may be unavoidable impacts that must be addressed in a culturally sensitive and timely manner to mitigate effects where possible and compensate for those effects that cannot be mitigated (NRC 2003a:148; USDOI, BLM, 2004).

4.4.1.12.6. Direct and Indirect Effects Under Alternative I.

Conclusion. There would be no direct or indirect impacts to subsistence resources or harvests in the project area from Lease Sales 209 or 217 if they were not held.

4.4.1.12.7. Cumulative Effects Under Alternative I.

Future MMS Sales 212 and 221 in the Chukchi Sea and ongoing projects in the region are summarized in Section 4.2.1. and include: (1) ongoing maintenance and development projects in local communities; (2) onshore oil and gas infrastructure development; (3) passenger, research, and industry-support aircraft activities; (4) local boat traffic, barge resupply to local communities, research vessel traffic, industry-support vessel activities (mostly in support of seismic surveys), an increasing U.S. Coast Guard presence, and vessel traffic from increasing ecotourism in the Arctic. Ongoing actions include: (1) development and production activities at Endicott, Northstar, Badami, and Alpine; (2) recent leasing from Beaufort Lease Sales 195 and 202; (3) State leasing; and (4) onshore leasing activity in the NPR-A. Other projects include BP's restart of the Liberty Development Project east of Endicott; Pioneer Natural Resources Co.'s development of its North Slope Ooogruk field in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit; and the Nikaitchug Development Project also in State waters off the Colville Delta. In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling

off the Mackenzie River Delta, and GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area (USDOI, MMS, 2006a).

In the Chukchi Sea west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the Delong Mountain Terminal (DMT). These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the planning area (USDOI, MMS, 2006a).

Summary. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development reduces the availability of resources or alters their distribution patterns. Cumulative effects to bowhead whales and other marine mammals is a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas and the traditional bowhead whale harvest could be adversely affected. The same could be true for beluga whales, walrus and seals (USDOI, MMS, 2003a). The disruption of bowhead whale harvests could result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals—making them more skittish, for example—in reaction to OCS activities. The greater the degree of activity onshore and oil and gas development in Federal, State, and Canadian waters, as measured by increases in seismic noise, vessel traffic, east-to-west development, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. If the IWC considers the threat of industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope as well as to Iñupiat in other communities who receive whale meat from the harvest (USDOI, BLM and MMS, 1998).

Onshore development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from non-subsistence hunters for fish and wildlife (Haynes and Pedersen, 1989). Additive impacts that could affect subsistence resources include potential oil spills; seismic noise; road and air traffic disturbance; and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas farther from the local subsistence communities would require increased effort, risk, and cost on the part of subsistence users. Increasing onshore areas open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence-harvest efforts in the undeveloped areas and increasing the potential for conflict over harvest areas within a community (USDOI, BLM, 2005). Based on potential cumulative, long-term displacement and/or functional loss, habitat available for caribou may be reduced or unavailable or undesirable for use. Changes in caribou population distribution due to the presence of oilfield facilities or activities may affect availability for subsistence harvest in traditional subsistence use areas. The communities of Nuiqsut, Barrow, and Atqasuk would be most affected by ongoing onshore activities (USDOI, BLM, 2004).

If a large oil spill occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season even though whales still would be available. In fact, even if whales were available for the spring and fall seasons, traditional

cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest in Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope, and the beluga whale hunt in Point Lay for up to two seasons. Concerns over the safety of subsistence foods could persist for many years past any actual harvest disruption. This would be a major adverse effect. In terms of other species, this same concern also would extend to walrus, seals, polar bears, fish, and birds.

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet could be expected. Increased climate changes are likely to continue to affect subsistence activities; additional losses of traditional subsistence harvest areas would occur and traditional subsistence resources might no longer be available for harvest (e.g., some species of migratory birds). Subsistence users would continue to travel farther to harvest resources, but are unlikely to cease subsistence harvests given the strong cultural continuity and value of subsistence activities (Johannessen, Shalina, and Miles, 1999; IPCC, 2001b; NRC, 2003a; NMFS, 2008b; USDO, BLM, 2005).

Conclusion. Without proposed mitigation in place, cumulative effects on subsistence resources and harvests from noise and disturbance would be major. To a large extent, existing stipulations and required mitigation have in the past mitigated such potential effects and may continue to do so. With an MMS-approved industry AMMP in place, effects would be reduced to moderate. Additionally, stipulated measures for seismic-survey permits and mitigation accompanying NMFS IHA plans generally ensure that acceptable levels of whale monitoring will occur. Together, these measures should ensure that no unmitigable adverse effects to subsistence-harvest patterns, resources, or practices will occur. Cumulative impacts from a large oil spill, when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together, would be considered major effects. If present rates of climate change continue, impacts to subsistence resources and subsistence harvests would be expected to be major (USDO, MMS, 2007d).

4.4.1.13. Sociocultural Systems.

Summary. There would be no direct or indirect impacts to sociocultural systems in the project area from Lease Sales 209 or 217 if they were not held. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk could come from disturbance from oil exploration and development activities, from changes in population and employment, and subsistence-harvest patterns; accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources. However, such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion); social organization; or sociocultural systems (USDO, BLM and MMS, 2003; USDO, MMS, 2006b).

More air traffic and non-Natives in the North Slope region could increase interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow, Atqasuk, and Kaktovik (USDO, MMS, 2003a).

For 2D and 3D seismic surveys in the Beaufort Sea region, effects to sociocultural systems are expected to be minimal. Effects to social well-being (social systems) would be noticeable because of concern over deflection of the bowhead whale due to seismic-survey activities and the attendant effects on the subsistence harvest. These concerns may translate into greater activity as various institutions seek to influence the decisionmaking process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If the deflection actually occurs, effects could be major (USDOJ, MMS, 2007d).

On and offshore, as the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atkasuk depend on the subsistence caribou harvest from the CAH and the TCH; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns, including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources; social bonds; and cultural values. If oil and gas development occurs near the north shore of Teshekpuk Lake and is connected by roads and pipelines to the Alpine field, an important subsistence-use area used by residents of Nuiqsut, Barrow, and Atkasuk could be avoided by subsistence users. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence-resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment (USDOJ, BLM, 2004; USDOJ, BLM and MMS, 1998).

If a large spill contacted and extensively oiled coastal habitat, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Such impacts would be considered major. All subsistence whaling communities and other communities that trade for and receive whale products and other resources from the whaling communities could be affected. A large spill anywhere within the habitat of bowhead whales or other important marine mammal subsistence resources could have multiyear impacts on the harvest of these species by all communities that use them. In the event of a large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. In addition, harvests could be affected by the IWC, which could decide to limit harvest quotas in response to a perceived threat to the bowhead whale population (USDOJ, MMS, 2003a, 2006b; USDOJ, BLM and MMS, 2003).

Beyond the impacts of a large spill, long-term deflection of whale migratory routes or increased skittishness of whales due to increasing seismic surveys and industrialization in the Beaufort Sea would make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated although a predominant concern continues to be potential disruption associated from seismic-survey noise on subsistence-harvest patterns, particularly on the bowhead whale—a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Such disruptions could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems (USDOJ, MMS, 2006a).

Onshore, because Nuiqsut is relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community, a major effect; however, overall

effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. This same potential exists for the communities of Barrow, Atkasuk, and Kaktovik as Beaufort Sea areawide leasing, exploration, and development proceeds on- and offshore. Any potential effects to subsistence resources and subsistence harvests and consequent impacts on sociocultural systems are expected to be mitigated substantially, though not eliminated (USDOI, MMS, 2003a, 2004, 2006b).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and, considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses, as well as impacts to population, employment, and local infrastructure. The termination of oil activity could result in the outmigration of non-Inupiat people from the North Slope, along with some Inupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally constrained, postoil-production environment. If subsistence livelihoods are disrupted, Inupiat communities could face increased poverty, drug and alcohol abuse, and other social problems resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on non-subsistence foods (Langdon, 1995, Peterson and Johnson, 1995, National Assessment Synthesis Team, 2000, IPCC, 2001).

In the following analysis, we describe the potential effects to sociocultural systems from a variety of existing sources. We then describe mitigation measures that would avoid or minimize some of these impacts.

The past and present condition of sociocultural systems that potentially could be affected by the proposed Chukchi Sea and Beaufort Sea lease sales is described below, as well as the historic and present status of oil and gas development and other human activities on the North Slope and adjacent offshore areas (see Section 3.4.3). This is the baseline condition against which future impacts were evaluated. In the case of Alternative 1, No Lease Sale, the environmental consequence would be how the resource would be affected by reasonably foreseeable future events that did not include any lease sales proposed under this EIS. We determined the scope of the projects to include oil and gas development, other human activities, and environmental trends on the North Slope and adjacent offshore areas over the life of the proposed projects. Weighed more heavily are those activities that were more certain and closer in time and geography to the proposed lease-sale areas to keep the cumulative effects analysis concentrated on the effects in the proposed sale areas. Activities further away in time or further from the lease sale areas were considered more speculative and not reasonably foreseeable. In this section, we consider activities or events that are likely to occur regardless of leasing decisions made under this EIS. We primarily identify anticipated oil and gas exploration and development and production activities and projects in onshore and offshore areas of the Alaska North Slope.

It could be argued that the principal impacts to sociocultural systems in the region would be in the areas of subsistence, with implications for health, population, and the economy. All of these topics are discussed below or in other sections. At another level, this analysis would be remiss if it did not again draw attention to the unique combination of benefits and costs that petroleum development has fostered in Arctic Alaska, especially on the North Slope, primarily through the NSB and various Native organizations. The more general agencies of change, of course, are the increased availability of monetary resources, the Alaskan/American political system, and the American/world system of free exchange. In other Arctic Alaskan areas without petroleum development but with other resource development, such as the Northwest Arctic Borough (NWAB), the same dynamics are present, although with a reduced scope. Potential OCS activity, and the proposed program in particular, would support these established trends. Much of the regional sociocultural effects of OCS activities would be indirect or induced as the result of State programs, as most OCS population and economic effects would not be directly evident at the

regional level. Rather, they would be most evident at the State and large-population-center levels (USDOJ, MMS, 2007c).

At the same time, it is critically important to recognize that social systems and cultures are seldom, if ever, in a stable state. Culture is learned from one's teachers (parents, relatives, community, etc.), which tends to be an influence for continuity, and personal experience in an environment that is often different from that of one's teachers, which tends to be an influence for adaptation and change. Thus, many of the items on any list of sociocultural concerns also should be analyzed in the context of adaptive change. Changes in some categories of behavior do not necessarily reflect changes in cultural values. For instance, smaller household size may be a measure of the fragmentation of "traditional" social organization. However, it is more likely a reflection of the increased availability of housing, exposure to the model of the "American nuclear family," increased local wage-labor opportunities, better health care and support services for older people living independently, and other factors. What is often perceived as the "erosion of cultural values" often is only a transformation or change in the behavioral expression of that value (modes of sharing, expressions of respects). On the other hand, it also must be recognized that some behavioral changes are more significant indicators of cultural and value change than others. That is perhaps why public testimony on the impacts of petroleum development in Arctic Alaska, especially that of Native Elders, has focused on subsistence resources and practices, the relationship of people to the land and its resources, health, increased social pathologies, and the use (and loss) of Native languages. While OCS and other State and local actions contribute incrementally to these effects, it is vitally important to recognize that these activities would occur within this context (USDOJ, MMS, 2007c).

Some of the vectors of sociocultural change that commonly have been noted in studies of Arctic Alaska (Klausner and Foulks, 1982; Kruse et al., 1983a,b; Galginaitis et al., 1984; Luton, 1985; Worl and Smythe, 1986; Kevin Waring Associates, 1988; Chance, 1990; Impact Assessment, Inc., 1989a,b; Jorgensen, 1990; Human Relations Area Files, 1992); lease-sale documents (USDOJ, MMS, 1990a, 1996a, 1998a, 2001, 2002, 2003a, 2004, 2006a,b,c, 2007d; USDOJ, BLM, 1998, 2004a, 2005, 2007; USDOJ, BLM and MMS, 2003); or testimony during the lease-sale process (numerous USDOJ documents, 1978 to the present time) can be briefly summarized as follows:

- Changes in community and family organization (availability of wage-labor opportunities locally or regionally, ethnic composition, factionalism, household size);
- Institutional dislocation and continuity (introduction of new institutions, "loss" or de-emphasis of older or more traditional ones, and adaptation of new forms to old content or values, and vice versa);
- Changes in the patterns of overall subsistence activities (time allocation, access, effort, equipment and monetary needs) and the potential disruption of subsistence harvest activities by industrial development;
- Changes in health measures, which are a combination of increased access to health care, changes in diet, increased exposure to disease, substance use and abuse, concern over possible exposure to contaminants of various sorts, and other factors;
- Perceived erosion of cultural values and accompanying behaviors (increased social pathologies such as substance abuse, suicide, and crime/delinquency in general; decreased fluency in Native languages; decreased respect for Elders; less sharing); and
- Cultural "revitalization" efforts such as dance groups, Native language programs, and official and regular traditional celebrations (such as the reestablishment of Kivgiq [the Messenger Feast], for example, in the NSB) (USDOJ, MMS, 2007c).

While these are all in some sense generalizations and "analytical constructs," all are also supported by specific testimony of Native residents of the region. These dynamics generally are not viewed as oil- and

gas-development (let alone OCS) specific but rather as the overall context within which Inupiat culture must continue to exist.

Many studies have examined the relationship between subsistence and wage economies and how both subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. Although not always explicit, it is recognized that all rural communities and rural socioeconomic systems are not the same. One salient variable is the ethnic composition of the community, while another is the diversification of the local economy and the availability of wage employment. An extensive study series was conducted across a wide range of Alaskan communities during the 1980s that focused on local patterns of wild resource use as a component of the overall economy (Galginaitis et al., 1984; Reed, 1985; Sobelman, 1985; Impact Assessment, Inc., 1989; Stratton, 1989, 1990, 1992). Additional community-specific studies are cited in Fall and Utermohle (1999). Some of these communities are predominantly Alaskan Native, others are predominantly non-Alaskan Native, while others are more ethnically “mixed.” Some have developed wage (or self-employment) economies; others have few such opportunities (NMFS, 2005).

Within the North Slope and Northwest Arctic Boroughs, both subsistence activities and wage economic opportunities are highly developed and highly dependent on each other (Kruse, Kleinfeld, and Travis., 1981; Kruse, 1982, 1991; Harcharek, 1995; Shepro and Maas, 1999). Those communities most active in subsistence activities tend to be those who also are very involved in the wage economy. That is, monetary resources are needed to effectively assist in the harvest of subsistence resources, both as they affect individual harvesters (e.g., to purchase a boat, snowmachine, four-wheeler or all-terrain vehicle, fuel, and guns and ammunition) or as they affect the head of a collective crew (e.g., for whaling). However, full-time employment also limits the time a subsistence hunter can spend hunting to after-work hours. During midwinter, this window of time is further limited by waning daylight. In summer, extensive hunting and fishing can be pursued after work and without any limitations. As one North Slope hunter observed: “The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together” (ACI, Courtneage, and Braund, 1984) (NMFS, 2005).

Impact Assessment Overview. The coastal communities of the Beaufort Sea—Kaktovik, Nuiqsut, Barrow and Atqasuk—participate in subsistence harvests of marine and terrestrial resources in the region. These resources, subsistence practices, and the sociocultural systems that comprise these communities could be affected by the effects agents discussed above.

This discussion is concerned with those communities that potentially could be affected by past and ongoing exploration, development, and production activities in the Beaufort Sea region. These include the communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow. The primary aspects of the sociocultural systems covered in this analysis are (1) social organization, (2) cultural values, (3) institutional organization, and (4) subsistence and social health as described in Sections 3.4.3. and 3.4.5.

The social organization of North Slope communities is based on kinship, marriage, and alliance groups formed by such characteristics as age, gender, ethnicity, community, and trade. Social organization is also based on the cultural values of the community including sharing, mutual support, and cooperation. It is assumed that effects on social organization and cultural values could be brought about at the community level by increased effects on subsistence-harvest patterns that could be associated with past and ongoing activities. Potential effects are evaluated relative to the tendency of introduced social forces to support or disrupt existing systems of organization, relative to how rapidly they occur and their duration (Langdon, 1995; USDO, MMS, 2003a, 2006a).

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns.

Threats to subsistence harvest success are likely as a result of the following factors:

- Displacement or deflection of subsistence resources from customary harvest locations;
- Reduced access to customary harvest areas where oil industry facilities are located because of perceived restrictions on hunting techniques, especially the use of firearms, and hindrance to passage during winter along raised road berms and pipelines; and
- Preference for animals not habituated to industry facilities (USDOJ, MMS, 2003a; USDOJ, BLM, 2004).

Onshore, as a result of these effects on traditional subsistence-use areas, especially those near Nuiqsut, subsistence hunters will likely travel farther and spend more time away from the community pursuing subsistence harvest activities. They also will have increased direct economic costs for subsistence resulting from increased fuel consumption and maintenance and repair of equipment. This could increase a problem many North Slope residents perceive: cash employment taking hunters away from the community, which can lead to their missing short-term subsistence opportunities (USDOJ, MMS, 2003a; USDOJ, BLM, 2004).

Effects on subsistence harvest and use, and any associated stress to community social organization, are most likely to occur onshore in the community of Nuiqsut because of its proximity to oil-patch infrastructure at Alpine and Prudhoe Bay. While community members of Barrow and Atkasuk all pursue subsistence activities in this area, they take a larger proportion of their subsistence harvest from other areas not directly affected and thus are less likely to experience subsistence-related disruption to their social organization. Kaktovik is largely removed from the onshore impact of oil patch development (USDOJ, MMS, 2003a; USDOJ, BLM, 2004).

Factors that are likely to cause stress or change to the social organization of the four communities include the following:

- Influx of non-Native residents not associated with an existing kinship group;
- Influx of nonresident temporary workers;
- Increased interaction between residents and oil-industry workers;
- Change in subsistence uses;
- Reduction or disruption of harvest production;
- Availability of new technologies (transportation, energy production, educational, etc.); and
- Increased or variable personal and family annual income (Alpine).

Onshore, potential changes to the cultural organization of Nuiqsut could occur as a result of continued oil development in the surrounding area. These changes, to the extent that they would occur, most likely would be related to increased stress in the community as a result of changes in the pattern and success of subsistence hunting. Changes to community social organization are not likely to occur as a result of the presence of additional industry workers in the region.

Offshore, impacts on sociocultural systems could occur from potential disruptions of seismic noise on subsistence-harvest patterns, particularly on the bowhead whale, which is a pivotal species to the Inupiat culture; such disruptions could impact sharing networks, subsistence task groups, and crew structures, and could cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Displacement of ongoing sociocultural systems by seriously curtailing community activities and traditional practices for harvesting, sharing, and processing subsistence resources also might occur (USDOJ, MMS, 2006a,b).

Factors Affecting Sociocultural Systems.

Social Organization. An analysis of the effects on sociocultural systems must first look at the social organization of a society that involves examining how people are divided into social groups and networks. The social organization is made up of households, families, and wider networks of kinship and friends that, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming subsistence resources. In many ways, this element describes the primary nongovernmental organization of the community. Potential effects to social organization could be realized if project-related activities alter employment or income characteristics of the area, change the demographics of the area, result in changes to the workforce, or otherwise affect the social well-being of area residents. Social groups generally are based on kinship and marriage systems and on nonbiological alliance groups formed by such characteristics as age, sex, ethnicity, community, and trade. Kinship relations and nonbiological alliances serve to extend and ensure cooperation within the society. Social organization could be affected by an influx of new population that causes growth in the community and change in the organization of social groups and networks (USDOJ, MMS, 2003a, 2007d).

Disruption of the subsistence cycle also could change the way these groups are organized. The sharing of subsistence foods is profoundly important to the maintenance of family ties, kinship networks, and a sense of community well-being. In rural Alaskan Native communities, task groups associated with subsistence harvests are important in defining social roles and kinship relations: the individuals one cooperates with help define kin ties, and the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others. Disruption of these task groups can damage social bonds that hold a community together. Any serious disruption of sharing networks can appear as a threat to the established way of life in a community and can trigger an array of negative emotions—fear, anger, and frustration—in addition to a sense of loss and helplessness. Because of the psychological importance of subsistence in these sharing networks, perceived threats to subsistence activities from oil development are a major cause for anxiety (USDOJ, MMS, 2003a, 2006a).

An ADF&G social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. One question asked was: “How do you think the offshore development of oil and gas in this area would affect the following resources available for harvest; would the resource decrease, not change, or increase?” Eighty percent of Nuiqsut respondents answered that fish resources would decrease, 87% said marine mammals would decrease, 43% said land mammals would decrease, and 55% said that birds would decrease; 67% were not in favor of the search for oil, and 42% believed the search for oil would have an adverse impact on subsistence; 68% were not in favor of the development and production of oil, and 52% believed that oil development and production would have an adverse impact on subsistence (Fall and Utermohle, 1995; USDOJ, MMS, 2003a).

An analysis of cultural values shows those values that are shared by most members of a social group. Generally, these values reflect what is desirable and represent what is accepted, explicitly or implicitly, by members of a social group. Forces powerful enough to change the basic values of an entire society would include a seriously disturbing change in the physical conditions of life—a fundamental cultural change imposed or induced by external forces. One example would be an incoming group that demands that residents accept their intrusive culture’s values. Another would be a basic series of technological inventions that change physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Disturbance from oil development may be such a change that could bring about dramatic changes to cultural values on the North Slope, including strong ties to Native foods, to the land and its wildlife, to the family, to the virtues of sharing the proceeds of the hunt, and to independence from institutional and political forces outside the North Slope (see

Section 3.4.3). A serious disruption of subsistence-harvest patterns could alter these cultural values (USDOJ, MMS, 2003a, 2006a).

For the system of sharing to operate properly, some households must be able to produce, rather consistently, a surplus of subsistence goods; it is obviously more difficult for a household to produce a surplus than to simply satisfy its own needs. For this reason, sharing, and the supply of subsistence foods in the sharing network, often is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by active producers (USDOJ, MMS, 2003a). Thus, when disturbance to the subsistence harvest occurs, it could disrupt the community culture. Subsistence is a cyclical activity, and harvests vary from year to year, sometimes substantially. Numerous different species are hunted to compensate for a reduced harvest of a particular resource in any one year. However, multiyear disruptions to some important resources, such as the caribou or the bowhead whale, could have substantial effects on sharing networks and subsistence-task groups, even though they do not cause “biologically significant” harm to a subsistence species’ overall population (USDOJ, MMS, 2003a, 2006a; USDOJ, BLM, 2004).

Subsistence and Social Health. Stress would occur if a village were not successful in the bowhead whale harvest, with potential disruption of sharing networks and task groups. This stress could disrupt the community’s social organization but likely would not displace the long-term social processes of whaling and sharing, if it did not occur often. Other more successful villages would share with a village having an unsuccessful whaling season. There have been no unsuccessful whaling seasons for Nuiqsut since 1994 and Kaktovik since 1991 (Braund, Marquette, and Bockstoce, 1988; Alaska Eskimo Whaling Commission, 1987-1995), and negotiated conflict resolution agreements between the AEWK, subsistence whaling communities, and the oil industry, in the past, have tended to serve as a practical means for coordinating whaling activities and potential disturbances to them from industry activities (USDOJ, MMS, 2006a).

Community Health and Welfare. Residents of North Slope communities, including the communities likely to be located near past and present development activities have documented increased rates of crime, drug abuse, domestic violence and child abuse, and other community welfare pathologies. While these health and welfare problems have increased over the time of oil-industry development on the North Slope, they have not been linked directly to oil industry activity. Their occurrence is symptomatic of changes in community social organization, economy, and increased access to technology and sources of cash income (USDOJ, BLM, 2004).

Any effects on social health would have ramifications on social organization. On the other hand, NSB Native communities, in fact, have proven quite resilient to such effects with the Borough’s continued support of Inupiat cultural values and its strong commitment to health, social-service, and other assistance programs. Health and social-service programs have attempted to meet the needs of alcohol- and drug-related problems by providing treatment programs and shelters for wives and families of abusive spouses and by placing greater emphasis on recreational programs and services. However, in comments before the Department of the Interior’s OCS Policy Committee’s May 2000 meeting, NSB Mayor George Ahmaogak stated that Borough residents are extremely concerned that a lack of adequate financing for local NSB city governments has hampered the development of these programs, and declining revenues from the State of Alaska have seriously impaired the overall function of these city governments. Partnering together, Tribal governments, city governments, and the NSB government have been able to provide some programs, services, and benefits to local residents. For several years, all communities in the Borough have banned the sale of alcohol, although alcohol possession is not banned in Barrow, and many communities are continually under pressure to bring the issue up in local referendums (NSB, 1998). Effects on social health in Nuiqsut would have direct consequences on sociocultural systems but would

not tend toward the displacement of existing systems above the displacement that has already occurred with the current level of development. To the extent that changes in the subsistence harvest place stress on other elements of community structure, indirect impacts on community health and welfare would occur (USDOJ, BLM, 2004; USDOJ, MMS, 2006a). See also Section 4.4.1.15 Environmental Justice for an assessment of North Slope human health conditions and impacts.

Stress created by the fear that oil exploration, development, and production (and anticipated oil spills) will soon follow the seismic surveys is a distinct predevelopment impact-producing agent. Stress from this general fear can be broken down into the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- having to employ and work with lawyers to draft litigation in attempts to stop proposed development (USDOJ, MMS, 2006a)

Cultural Values. An analysis of a social group's cultural values is desirable and represents what is accepted, explicitly or implicitly, by its members. Cultural values emphasize the Inupiat's close relationship with natural resources, with particular focus on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that embodies these values, with bowhead whale hunting the paramount subsistence activity. Potential effects to cultural values could be realized if project-related activities alter subsistence harvest, known archaeological or cultural sites, and cultural continuity. In some respects, this element overlaps with social organization (USDOJ, MMS, 2007d). Forces powerful enough to change the basic values of an entire society would include a seriously disturbing change in the physical conditions of life—a fundamental cultural change imposed or induced by external forces. One example would be an incoming group that demands that residents accept their intrusive culture's values. Another would be a basic series of technological inventions that change physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Disturbances to subsistence-harvest patterns from seismic surveys might induce such a change, i.e., changes to cultural values on the North Slope, including strong ties to Native foods, to the land and its wildlife, to the family, to the virtues of sharing the proceeds of the hunt, and to independence from institutional and political forces outside the North Slope (USDOJ, MMS, 2006a).

Institutional Organization. Institutional organization encompasses the structure and functions of borough, city, and tribal government, and related formal organizations such as the Alaska Native Regional and various village for-profit and not-for-profit corporations, and nongovernmental organizations. In many ways, this element describes the governmental and related functions of the community. Potential effects to institutional organization could be realized, if project-related activities affect how institutions are structured or how they function to provide services and foster community stability (USDOJ, MMS, 2007d).

Industrial activities create the opportunity for institutions to participate in the planning process for the project at the local, State, and Federal level. These organizations bear the marginal costs of doing so.

Depending on the location, number, magnitude, and timing of development projects, the cumulative effect could challenge and possibly exceed the capacity of some organizations to effectively participate in the process. The timing of activities and the resources available to any given organization through the institutional network would mitigate to some degree this potential effect (USDOJ, MMS, 2007d).

Local Hire. Employment opportunities for local residents, especially Alaskan Natives, as a result of Alternative 1 could occur either as direct jobs for industry or as new jobs created as a result of increased local economic activity (so-called “induced employment”). Employment of Alaskan Natives in oil-related jobs on the North Slope has been low. In spite of this limited participation, community and NSB leaders continue to seek implementation of programs that would result in increased hiring of local residents, especially Alaskan Natives. The NSB has attempted to facilitate Native employment in the oil industry at Prudhoe Bay, and has expressed concern that industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural need to participate in subsistence hunting. The NSB also is concerned that even though recruitment efforts are made and training programs are available, industry recruits workers using methods more common to Western industry practices. Suggestions have been made that industry hiring practices be modified to become more Inupiat-appropriate. One North Slope operator, BPXA, has instituted its *Itqanaiyagvik* hiring and training program, designed to put more Inupiat into the oilfield workforce. It is a joint venture with the Arctic Slope Regional Corporation and its oil-field subsidiaries, and is coordinated with the NSB and the NSB School District. Other initiatives are an adult “job-shadowing” program and an effort called Alliances of Learning and Vision for Under Represented Americans, developed with the University of Alaska (BPXA, 1998a; USDOJ, MMS, 2003a; USDOJ, BLM, 2004).

As a result of continued industry and NSB efforts, some increase in employment of local residents in industry jobs is expected to occur, but the number employed is expected to be small. The industry practice of providing worksite housing and importing a significant segment of the workforce to the project site means that development-induced local employment is likely to be small, especially as translated into employment of Alaska Natives (USDOJ, MMS, 2003a; USDOJ, BLM, 2004).

Effects Definitions and Effects Levels.

1. Periodic, short-term effects with no measurable effects on normal or routine community functions, the lowest level of effect (a *negligible* effect).
2. Sociocultural systems being affected for a period up to 1 year, but effects would not disrupt normal or routine community functions and could be avoided with proper mitigation (a *minor* effect)
3. Effects on sociocultural systems would be unavoidable for a period longer than 1 year. Affected normal or routine community functions would have to adjust somewhat to account for impact disruptions, but they would be expected to recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated (a *moderate* effect).
4. Effects on sociocultural systems would be unavoidable and normal or routine community functions would experience disruptions to a degree beyond what is normally acceptable. Once the impacting agent is eliminated, affected community functions may retain measurable effects, even if proper remedial action is taken. This would constitute a major impact on sociocultural systems (a *major* effect).

4.4.1.13.1. Potential (Unmitigated) Effects to Sociocultural Systems. For purposes of analysis, it is assumed that effects on social organization and cultural values could be brought about at the

community level by increased population, by increased employment, and by effects on subsistence-harvest patterns predominantly from (1) vessel and aircraft noise and disturbance, (2) oil spills, (3) seismic surveys, (4) habitat loss, (5) other sources, (6) production activity, and (7) climate change. Analytical descriptions of affected resources and species in addition to indigenous Inupiat knowledge concerning effects are described in detail (USDOJ, MMS, 2003a, 2007d).

4.4.1.13.1.1. Potential Effects from Disturbance. Because staging for offshore exploration, development, and production activities normally comes from existing infrastructure in Deadhorse, social systems in the communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk would experience little direct disturbance from the staging of people and aircraft transportation for exploration and development in the region. Onshore, these activities would tend to disrupt subsistence harvests to the extent that they overfly important subsistence-use areas. Overall, these activities are expected to have little effect on sociocultural systems. Oil workers likely would not interact with Kaktovik, Nuiqsut, Barrow, and Atqasuk residents, and there would be no expected displacement of social systems. Also, minimal local changes in population and employment are not likely to disrupt sociocultural systems (USDOJ, MMS, 2003a). Potential disturbance effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.

4.4.1.13.1.2. Potential Effects from Oil-Spills.

Large Oil Spills. Oil spills probably are the most significant potential source of adverse effects attributable to the proposed action. Negative effects to specific subsistence species, as well as to the more general patterns of subsistence resource use, would reduce the availability and/or accessibility of subsistence resources typically for a single season or less, but potentially for longer periods. The sociocultural impacts of oil spills are of at least two types. The first is the result of direct effects on resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life). The second is the impact of spill-cleanup efforts, in terms of short-term increases in population and economic opportunities, as well as increased demand on community services and increased stress to local communities (USDOJ, MMS, 2007c). Potential large oil-spill effects on subsistence resources and practices were discussed in Sections 4.4.1.12.1.4.1.

Effects on the sociocultural systems of local communities could come from disturbance from small changes in population and employment, periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup, and stress due to fears of a potential spill and the disruptions it would cause. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales and other marine mammals from an oil spill, and overall effects from these sources could be expected to displace ongoing sociocultural systems (USDOJ, MMS, 2007d).

Stress created by the fear of an oil spill also is a distinct predevelopment impact-producing agent within the human environment. Stress from this general fear can be broken down to the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;

- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- having to employ and work with lawyers to draft litigation in attempts to stop proposed development (USDOJ, MMS, 2007d).

More specifically, disruption of subsistence-harvest resources, such as that created by a large oil spill, would have predictable and significant consequences and would affect all aspects of sociocultural resources—social organization, cultural values, and institutional organization (Luton, 1985). The primary effect would be the depletion each Native family's stored foods and harvesting of less-preferred resources. However, concerns over tainting would create a reluctance to consume suspect resources. The harvest of less-preferred resources would be more time, labor, and equipment intensive (USDOJ, MMS, 2007d).

Social-organization effects would be very pronounced. Social well-being would be affected, as risk, safety, and health concerns would increase as the work of harvest became more intensive, increasing the likelihood of equipment breakdowns and accidents among harvesters. Increased demands would be placed on the networks in which each household participated, as available resources were redistributed according to need. If scarcity continued, greater requests would be made, first to nearby communities and then to those beyond (Fairbanks, Anchorage, and other cities in and outside Alaska).

These requests, in turn, would accelerate the depletion of the resources of the contributing networks. Employment and income effects could be realized as cash was expended to maintain equipment and purchase food at local stores to make up for the shortfall in harvested foods. Lines of credit would be stretched. Workforce changes and demographic changes could occur with consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment, further depleting the pool of available subsistence producers and affecting the structure of households and reducing the stability of families and communities (USDOJ, MMS, 2007d).

Stress to subsistence and sharing could affect the very central core values of Inupiat culture. The inability of the community's leaders—the subsistence providers—to fulfill their role would have negative effects on community stability. Over time, if knowledge holders or recipients are removed from the community, spiritual teaching and knowledge transfer that takes place as part of the hunt would be diminished. The loss of equipment and property used in subsistence harvests and foreclosure of use of the materials needed to produce objects of cultural expression and trade—an important source of supplemental income to approximately one in five households—also could result (USDOJ, MMS, 2007d).

Institutional organizations would be affected as requests for temporary assistance from various public and private institutions would likely increase. As cash was diverted to meet the increased costs of food, other expenses such as utilities might go unpaid. Demands for corrective actions by organizational institutions are likely to increase, with institutions working cooperatively to find solutions to the problem. However, if corrective action did not sufficiently address the effects, legal action and other forms of social action could increase eroding cooperation between institutions (USDOJ, MMS, 2007d).

Onshore, an oil spill could result in contamination of subsistence resources and would be a threat to the health and lifestyle of the affected communities. If a large oil spill occurred in a traditional-use area, then subsistence users would have to travel farther to harvest uncontaminated resources, which would result in high effects to sociocultural patterns for a much longer time than the period that subsistence resources would be measurably contaminated. Because it is expected that oil spills from normal activities would be small, chronic events and normally would be contained on the drill pad, effects from the spills themselves and potential disruptions from cleanup activities would be unlikely to cause excessive disturbance to sociocultural systems or the surrounding environment (USDOJ, BLM, 2005).

4.4.1.13.1.3. Potential Effects from Oil-Spill Response and Cleanup. Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and disrupt some sociocultural systems, and could further displace these systems, although cleanup activities alone are not sufficient to cause displacement. The sudden employment increase could have sudden and abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs. Cleanup is unlikely to add population to the communities, because administrators and workers would live in separate enclaves (USDOJ, MMS, 2003a, 2007d). Potential oil-spill-response and -cleanup effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.4.2.2.

Industry oil-discharge prevention and cleanup-contingency plans would be expected to include scenarios for cleaning up oil in open water, solid ice, and broken ice. These scenarios would have to identify logistics, equipment, and tactics for the various cleanup responses. Spill cleanup would reduce the amount of spilled oil in the environment and tend to mitigate spill effects. If a large spill contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Employment generated to clean up a large oil spill could call for 60-190 cleanup workers. A decline in the certainty about the safety of subsistence foods, potential displacement of subsistence resources and hunters, and changes in sharing and visiting could lead to a loss of community solidarity. Far from providing mitigation, oil-spill-cleanup activities more likely should be viewed as an additional impact, causing displacement and employment disruptions (Impact Assessment, Inc., 1998; USDOJ, MMS, 1007d).

4.4.1.13.1.4. Potential Effects from Seismic Surveys. Potential seismic survey effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.5.

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk, could come from noise disturbance produced by seismic exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of personnel and equipment for seismic exploration (USDOJ, MMS, 2006a,b, 2007d).

However, the possible long-term deflection of whale migration routes or increased skittishness of whales due to seismic-survey activities in the Beaufort and Chukchi Seas might make subsistence harvests more difficult, dangerous, and expensive. The more predominant issue associated with potential impacts on sociocultural systems is the potential disruption of seismic-survey noise on subsistence harvest patterns, particularly those involving the bowhead whale, which is a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. Over time, these disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Displacement of ongoing sociocultural systems by seriously curtailing community activities and traditional practices for harvesting, sharing, and processing subsistence resources could occur (USDOJ, MMS, 2006a,b, 2007d).

4.4.1.13.1.5. Potential Effects from Habitat Loss. Potential habitat loss effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.6.

4.4.1.13.1.6. Potential Effects from Onshore Development. Potential onshore development effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.7.

Many of the effects from exploration are similar to those effects from seismic surveys, because the most of the activities based on largely self supporting vessels, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal. Therefore, social systems in these communities would experience little direct disturbance from the staging of personnel and equipment for exploration (USDOI, MMS, 2007d).

Onshore development proposed for the Alpine satellite fields and reasonably foreseeable exploration in NPR-A would require increased staging and overland travel during the winter; in summer, there would be an increased use of aircraft for supplies, equipment, and crew changes. In all seasons, noise, lights, personnel, and traffic near oil and gas infrastructure temporarily could deflect or divert caribou in areas where activities are occurring; however, gravel pads could provide caribou with insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure on the part of subsistence hunters, resulting in sociocultural consequences, such as increased stress and a decreased sense of well-being. Oil and gas development could divert subsistence users from facilities at distances from 5 to more than 25 mi. Given the high gasoline costs on the North Slope, this would add additional cost to subsistence harvests. Increased fuel costs and wear and tear on hunters and their equipment would increase the need for wage labor to support subsistence pursuits and reduce the time available to pursue subsistence activities, which would result in sociocultural consequences, such as increased stress and a decreased sense of well-being. Increases in the speed, range, and reliability of outboards and snowmachines have facilitated the mixed subsistence and wage economy, but likely would not compensate for impacts to subsistence-harvest activities from continued development and production activities in important subsistence harvest areas (USDOI, BLM, 2005).

Long-term change to sociocultural patterns would result from a weakening of stabilizing traditional institutions through prolonged stress and disruptive effects that could be exacerbated by activities occurring onshore near Nuiqsut. These changes already are occurring to some degree on the North Slope because of onshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructures, increased presence of non-Natives, increased travel outside of the North Slope, and increasing penetration of television and the Internet. NSB institutions, such as the school district that promotes the teaching of Iñupiat language and culture, the AEWG that negotiates with industry to protect Iñupiat subsistence whaling interests, the NSB Department of Wildlife Management, and other regional and village Native corporations and organizations, have been working vigorously and successfully to prevent the weakening of traditional Iñupiat cultural institutions and practices. Increased social interactions between oil-industry workers and Nuiqsut residents could occur over the long term, but there is not expected to be a tendency toward displacement of their social institutions. Changes in population and employment are unlikely to immediately disrupt sociocultural systems or displace existing institutions but could, if large population changes occurred in response to development and the communities were overrun with new residents (USDOI BLM and MMS 1998, 2003; USDOI, BLM, 2004, 2005).

An additional onshore threat is reduced access to customary harvest areas where oil industry facilities are located because of perceived restrictions on hunting techniques, especially the use of firearms, and hindrance to passage during winter along raised road berms and pipelines (USDOI, BLM, 2004). Effects on subsistence harvest and use, and any associated stress to community social organization, are most likely to occur in the community of Nuiqsut because of its proximity to onshore construction and operations. While community members of Barrow and Atkasuk all pursue subsistence activities in the area, they take a larger proportion of their subsistence harvest from other areas not directly affected and,

thus, are less likely to experience subsistence-related disruption to their social organization (USDOJ, BLM, 2004). Kaktovik largely has avoided onshore impacts associated with oil development at Prudhoe Bay.

Potential effects on archaeological sites as a result of development and construction activities could occur. Essentially, potential effects include disturbance of traditional use and archaeological sites, such as hunting, fishing, and whaling camps, by construction and the increased possibility for vandalism. Any effects to these resources would have a corresponding and proportional effect on cultural values (USDOJ, MMS, 2007d).

4.4.1.13.1.7. Potential Effects from Production Activities. Potential production activity effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.8.

No direct and immediate impacts are expected to community social organization, community services, or community health and welfare as a result of onshore production impacts. If impacts in these sectors of community life occur as an indirect result of project development, such impacts are likely to occur over a longer time period and incrementally. A number of indicators of overall community welfare have been identified in previous studies prepared for Nuiqsut's *Kuukpikmuit* Subsistence Oversight Panel (Circumpolar Research Assocs., 2002), where local oil operators would assist in continued monitoring of the social indicators on a periodic basis to provide additional information to community leaders and appropriate social, health, and law enforcement organizations on overall community welfare. Such information could then be used to prioritize budgeting of community and NSB resources to address selected community welfare issues (USDOJ, BLM, 2004).

Onshore, abandonment and rehabilitation activities would be expected to restore habitat for caribou and other subsistence species; subsistence resources would be subject to fewer impacts, potentially improving subsistence opportunities. Abandonment and rehabilitation activities likely would provide jobs for local residents for several years. However, after oil and fields were reclaimed and abandoned, jobs associated with them would cease. At present, very few long-time Nuiqsut residents have jobs in the oil fields; people instead move to Nuiqsut if they get employment at the oil fields (Circumpolar Research Assocs., 2002). If local residents were to become substantially integrated into oil field operations and the local communities were to become dependent on revenues associated with their operation, the community would face a period of sharp adjustment as fields were abandoned. The NSB is undergoing a period of contraction in services and funding as oilfield revenues decline, and has had to cut police presence and privatize services in some rural communities (NSB, 2000, *Anchorage Daily News*, 2004, USDOJ, BLM, 2005).

4.4.1.13.1.8. Potential Effects from Climate Change. Potential climate change effects on subsistence resources and practices were discussed in Section 4.4.1.12.1.9.

4.4.1.13.2. Mitigation Measures. Applicable mitigating measures for sociocultural systems would be similar to the discussion for subsistence-harvest patterns in Section 4.4.1.12.2.

Onshore, BLM performance-based lease stipulations and required operating procedures for Northeast and Northwest NPR-A leasing actions and Alpine satellite development activity are expected to minimized onshore impacts to subsistence resources and harvest activities and any consequent sociocultural impacts. These measures would provide setbacks from rivers and lakes and require the lessee to provide a cultural orientation program for all oil and gas personnel involved in onshore activities. These stipulations for general disturbance, general damage, and the chasing of wildlife, as well as the wildlife stipulations for

polar bears, caribou, and birds, afford effective subsistence-resource protection that, in turn, helps reduce impacts to the area's sociocultural systems (USDOI, BLM, 2004, 2005).

4.4.1.13.3. Traditional Knowledge on Effects from Vessel and Aircraft Disturbance, Discharges, Large Oil Spills and Cleanup, Small Oil Spills, Seismic Surveys, Other Sources, and Climate Change. Traditional knowledge on these effects, as it applies to both Chukchi and Beaufort sea subsistence communities, appears in Section 4.4.1.12.3. Sociocultural-specific traditional knowledge is included below.

Rex Okakok from Barrow expressed a fundamental problems for Inupiaq culture from outside interests, saying: "Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat" (Okakok, 1987, as cited in USDOI, MMS, 1987a). Considering such use of Inupiat territory, Robert Edwardson from Barrow said that he would like to see revenues paid to the Inupiat for mineral rights (Edwardson, 1995, as cited in USDOI, MMS, 1995b). All three communities believe that some form of impact assistance should be forthcoming to compensate them for absorbing the social impacts from oil development that have occurred and that are to come (USDOI, MMS, 2003a, 2006a).

At hearings in 1982, Mark Ahmakak from Nuiqsut stated that there should be economic benefits to Nuiqsut, such as cheaper diesel (Ahmakak, 1982, as cited in USDOI, MMS, 1982). The consensus is that some benefit should come to the community from nearby oil activities. Nuiqsut resident Joseph Ericklook expressed the community's wish to see employment opportunities for local people result from development (Ericklook, 1990, as cited in USDOI, MMS, 1990d). In a 1996 public meeting for the Northstar Project, a Nuiqsut elder stated that she wanted potential human-health issues that could result from the project looked into beforehand. These issues could be found in information from other projects. She specifically expressed concern about cancers, health problems related to air pollution, and shortened lifespans (Dames and Moore, 1996a; USDOI, MMS, 2003a, 2006a).

As early as 1983, Nuiqsut residents asked to be part of industry activities in the region. Mark Ahmakak stated: "I think that if you are going to go ahead with this sale that you should utilize Natives in the areas affected by this lease sale; then utilize some of these Natives as monitors on some of your projects" (Ahmakak, 1983, as cited in USDOI, MMS, 1983a). There are concerns about protecting traditional sites from development. Nannie Woods expressed her opposition to leasing in the Colville River Delta because of her concern that her husband's burial site might be disturbed by development (Woods, 1982, as cited in USDOI, MMS, 1982). Recently, a Nuiqsut elder had her "home place" at Prudhoe Bay desecrated by an oil company. Her house was looted and built over. She emphasized that graves of family members are in the area and that she has been denied access there (Dames and Moore, 1996a). At a November 1999 MMS Liberty Project Information Update Meeting in Nuiqsut, Elders told MMS to be aware of gravesites on the shoreline of Foggy Island Bay (USDOI, MMS, 2003a, 2006a).

Former Mayor Lon Sonsalla of Kaktovik believes that to keep up with development activities, the village needs an impact office there to review EIS documents and monitor offshore activities (Sonsalla, 1996, as cited in USDOI, MMS, 1996d). During MMS scoping meetings for Sale 170, in November 1996, Susie Akootchook, Village Coordinator for Kaktovik, commented that traditional fishing and hunting sites need protection, and that a contingency plan needs to be developed to protect them (Burwell, 1996, pers. commun., USDOI, MMS, 2003a, 2006a).

At a town meeting for the Northstar Project, Nuiqsut residents reiterated that they do not believe the technology exists to clean up an oil spill under the ice; they believe it is a matter of when a spill will occur, not if it will occur. They want assurance against disaster and want impact funds set aside for them

if a spill occurs (Dames and Moore, 1996a). Earlier village comments expressed the same attitude (USDOI, MMS, 2003a, 2006a).

In 1979, Gordon Rankin from Kaktovik suggested that a compensation fund be set aside for villages, in case there is a devastating oil spill (Rankin, 1979, as cited in USDOI, BLM, 1979b; USDOI, MMS, 2003a, 2006a).

Barrow resident Charles Okakok said that subsistence users should be compensated by the oil industry in case of an oil spill (Okakok, 1995, as cited in USDOI, MMS, 1995b). Natives living on the North Slope often have repeated this sentiment (USDOI, MMS, 2003a, 2006a).

Nuiqsut residents clearly want to be active in any spill response and cleanup. At a community meeting for the Northstar Project, the people of Nuiqsut said they wanted to be part of a newly formed village oil-spill-response team, so that they could positively contribute in an emergency situation (Dames and Moore, 1996a). Their involvement in the past has not always gone smoothly. At the same community meeting, two Nuiqsut men felt their skills and knowledge were not respected when asked to participate in an oil-spill-response drill on a rig near the Northstar Project in February 1991. They believed their skills and knowledge could have been better used by the command structure of that team (Dames and Moore, 1996a; USDOI, MMS, 2003a, 2006a).

An ADF&G social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. One question asked was: “How do you think the offshore development of oil and gas in this area would affect the following resources available for harvest; would the resource decrease, not change, or increase?” Eighty-percent of Nuiqsut respondents answered that fish resources would decrease, 87% said marine mammals would decrease, 43% said land mammals would decrease, and 55% said that birds would decrease; 67% were not in favor of the search for oil, and 42% believed the search for oil would have an adverse impact on subsistence; 68% were not in favor of the development and production of oil, and 52% believed that oil development and production would have an adverse impact on subsistence (Fall and Utermohle, 1995; USDOI, MMS, 2006a).

In 2002, North Slope subsistence whalers stated that present OCS deferral areas are too small. They believe there is a need for larger “Quiet Zone” deferral areas in the vicinity of Kaktovik, Cross Island, and Barrow that protect the bowhead whale migration route from seismic-sound disturbance; that protect subsistence staging, pursuit, and butchering areas; and that protect critical whale feeding and calving areas. They also suggested that MMS reinstate a Cross Island deferral area. Other controversial issues are:

- the ramping up of seismic exploration in the Beaufort and Chukchi seas;
- noise effects of onshore barge traffic and Canadian shipping on bowhead whales;
- the need to expand conflict avoidance agreements to other resources not considered by the AEWG, such as fish, bearded seals, walruses, and beluga whales;
- the need for MMS to coordinate with and include the BLM, NMFS, the U.S. Army Corps of Engineers, the Coast Guard, and the State of Alaska in its public outreach process and the need for a multiagency working group or coordination team made up of these agencies and governments;
- the need for MMS, BLM, and the State of Alaska to coordinate their projects, so as to recognize the linkage of onshore and offshore impacts and cumulative impacts;
- the need for MMS to revise its significance thresholds for subsistence and sociocultural systems and bring them in line with the MMPA’s “no unmitigable adverse impact” definition;

- the effects of global climate change on ice conditions, subsistence resources, and subsistence harvesting practices in the Alaskan Arctic; and,
- that increased industrial noise levels in the Beaufort Sea will force hunters to travel farther to find whales and that this may lead to reduced success and an increased struck and lost rate for hunters that may, in turn, cause the IWC to reduce the bowhead whale quota because of potential reduced hunting efficiency (USDOI, MMS, 2006b).

4.4.1.13.4. Anticipated Effects Under Alternative 1. The potential effects to subsistence-harvest patterns were described in Section 4.4.1.12.1. The potential effects on sociocultural systems were described in Sections 4.4.1.13.1. This section describes the impact on sociocultural systems resulting from the incremental impact of this action, Alternative 1 No Lease Sale, and adding it to other past and present actions regardless of what agency undertakes such actions. Past and present cumulative actions are described below as they have impacted specifically affected sociocultural systems. Reasonably foreseeable future actions are described in Section 4.2. To the extent that these actions impacted subsistence practices, they would have consequent impacts on sociocultural systems. These consequences will be discussed in the cumulative past and present action discussions below for specific impactors. Mitigation measures are described in Sections 4.4.1.12.2 and in Section 4.4.1.13.2.

Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures (e.g., commercial whaling, trapping, reindeer herding, military construction, oil and gas exploration and development); and regulatory actions (e.g., State and Federal regulations and IWC quotas). Adaptations to these external pressures resulted in intensified use of specific resources (e.g., bowhead whales, caribou, and furbearers) (USDOI, BLM, 2005).

The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision, given the lack of baseline data. Public testimony indicates that a relationship exists between oil and gas development and social stress or well-being (Ahtuanguak, 1997). One example of a study that is being conducted to explore this relationship is the MMS-sponsored study that analyzed NSB residents' observations and perceptions about effects from past, present, and future oil industry activities and other forces of modernity on their lives and subsistence whale hunting activities (EDAW et al., 2008). In addition, the NSB has submitted a grant request to the State of Alaska for a study of the cultural, social, and economic impacts to NPR-A subsistence communities resulting from current arctic oil and gas exploration and production. The North Slope Science Initiative also could affect scientific research projects (Argonne National Laboratory, 2004). Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts. Stress on North Slope sociocultural systems, which is generally under-reported and inadequately documented, includes residents' inability to access traditional-use areas, threats to resources/lifeways and to their spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a very large oil spill, and its effects on bowhead whales and other marine mammals, fish, and wildlife, is of great concern to residents, although no such spill has yet occurred on the North Slope. These stresses accumulate, because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion (NRC, 2003a; USDOI, BLM, 2005).

Despite effects to sociocultural systems from oil and gas development, what has remained constant over time is the centralization of leadership with whaling captains and their wives, a continued cultural and nutritional dependence on and desire for subsistence foods, a continued reliance on sharing and kinship, a

continued connection to family camps and land use areas, and the desire to have control over their communities' present and future. Whaling captains often are in positions of power in city, borough, and other institutions, and the institutions conform to the Iñupiat model of leadership and process. Subsistence foods are important for their nutritional value and their relatively low costs to the community, but most of all for the continued maintenance of the network of human and animal relationships, Iñupiat identity, and the activity of hunting, processing, and sharing as an outlet for individual social stress and a means of reducing community stresses (USDOJ, BLM, 2005).

The desire to have some control over the harvest areas they depend on, and the stress resulting from development and activities that conflict with their values with no recourse, is a significant stressor to individuals and communities. Some of these conflicts have been mitigated in the past, as in the case of oil/whaler's conflict avoidance agreements. Conflicts that are perceived to pit the Iñupiat against agencies and corporations contribute to feelings of futility, powerlessness, and despair, and when coupled with subsistence harvest shortfalls, pervasive unemployment, overcrowding, and other issues, significant and serious sociocultural consequences could result (Impact Assessment, Inc., 1990b). In the event that whaling quotas were reduced, whales were deflected offshore to avoid marine and air traffic and noise, or a significant marine oil spill occurred, whaling could be reduced or stopped, undermining the primary structure of social organization, traditional authority, and political power in the communities. NSB institutions, such as the school district that promotes the teaching of Iñupiat language and culture; the AEWG, which negotiates with industry and the IWC to protect Iñupiat subsistence-whaling interests; the NSB Department of Wildlife Management; Native regional and village corporations and tribal organizations, have been working vigorously and quite successfully at preventing the weakening of traditional Iñupiat cultural institutions and practices (NRC, 2003a; USDOJ, BLM, 2005).

The encroachment of oil-production facilities and infrastructure into areas formerly used for subsistence by the Iñupiat increases the difficulties faced by subsistence users in trying to provide culturally valued foods for their extended families. This encroachment includes the permanent oil infrastructure to the east, north, and west of Nuiqsut, as well as winter exploratory drilling and seismic testing in Inigok and other staging areas. The cycle of oil exploration, development, and production activities, as it is conducted both on- and offshore, has contributed to harvest shortfalls, a loss of cultural privacy, and challenge to traditional Iñupiat values. Frustration stemming from the inability to provide for the extended family or to exercise control over external factors further stresses people who are exposed to these problems (USDOJ, BLM, 2005).

In response to these types of social disruptions, the NSB, the AEWG, regional and Tribal governments, and village corporations have instituted efforts to foster and protect Iñupiat traditions. The BLM Subsistence Advisory Panel (SAP) is tasked with investigating conflicts between subsistence activities and oil and gas development, and making recommendations to the lessee and the BLM for resolution to protect sociocultural values. Health and social-service programs have tried to respond to alcohol and drug problems with treatment programs and shelters for abused spouses and families of abused spouses (USDOJ, BLM, 2004a, 2005).

Effective responses to other health issues, such as asthma, which is attributed by many local residents to exposure to increased pollution from oil-field operations, in addition to a background of cold weather and other injuries and illnesses, suffer from funding shortages. Additional information regarding the potential cumulative impacts to human health can be found in Section 4.4.1.15 Environmental Justice.

The cumulative effects of OCS and non-OCS activities on sociocultural systems and subsistence practices would be community specific and, in many cases, would not necessarily be due to new industrial activities. For example, The *Exxon Valdez* oil spill demonstrated that the rural communities of Prince William Sound are susceptible to sociocultural disruption from large-scale, time-compressed events,

particularly when they seriously disrupt subsistence resource use. For OCS activities, most supply and support bases would be located near existing industrial infrastructure. Population and employment changes associated with industrial growth would also be community specific. Industrial enclaves in general have reduced local community interaction with industry and have effectively reduced social disruption. To the extent that projected development can fit this model, effects would be minimized (USDOJ, MMS, 2007c).

Increased industrialization could lead to increased exposure of local residents to social, health, and well-being risk factors. Change associated with EuroAmerican contact, including industrial development, has been extensive and compressed within a relatively short period of time (USDOJ, MMS, 2007c).

Cumulative effects on the North Slope are expected to increase because, collectively, activities are expected to be more intense. More air traffic and non-Natives in the North Slope region could increase the interaction and (perhaps) conflicts with Native residents. In the past, non-Native workers have stayed in enclaves that kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. These workers already have made demands on the village for more electrical power and health care. This potential remains for the community of Barrow and Atkasuk as well (USDOJ, BLM and MMS, 2003).

In the cumulative case, specific effects on sociocultural systems could result from changes in population and employment, and changes in subsistence-harvest patterns, social bonds (social organization) and cultural values. Effects are expected from on- and offshore industrial activities, resulting from multiple lease sales in the NPR-A, and other ongoing or planned projects on the North Slope that would include State offshore lease sales, as well as other State and private activities (see Impact Assessment Inc., 1990a,b,c; 1998; Human Relations Area Files, Inc., 1995a,b,c; ADF&G, 1995a; USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003).

Increases in population growth and employment could cause long-term disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence production and consumption, (2) extended families, and (3) informally derived systems of respect and authority (mainly respect of elders and other leaders in the community). Cumulative effects on subsistence-harvest patterns (which also would be long term) would affect Inupiat social organization through disruptions to kinship ties, sharing networks, task groups, crew structures, and other social bonds. Effects on sharing networks and subsistence-task groups could break down family ties and threaten the communities' well-being, creating tensions and anxieties that could lead to high levels of social discord (USDOJ, BLM and MMS, 2003).

Cumulative effects on social organization could include decreasing importance of the family, cooperation, sharing, and subsistence as a livelihood, and increasing individualism, wage labor, and entrepreneurship. Long-term effects on subsistence-harvest patterns also would be expected. Chronic disruption could affect subsistence task groups and displace sharing networks, but it would not displace subsistence as a cultural value. Sociocultural cumulative effects of changing norms and values would be expected to affect all five social institutions (family, polity, economics, religion, and education), but the NSB's institutional infrastructure, the AEWC, community whaling organizations, regional and tribal governments, regional and village corporations, and the SAP work diligently to develop programs to protect these cultural values (Impact Assessment Inc., 1990a,b,c, 1998; Human Relations Area Files, Inc., 1995a,b,c; ADF&G, 1995a; USDOJ, BLM and MMS, 2003).

As a result of cumulative activities, there could be an increase in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The NSB already is experiencing problems in the social health and well-being of its communities, and additional development (including offshore oil development) on the North Slope would disrupt them

further. Historically, more income in these communities has connected somewhat to the abuse of alcohol and increased violence. Sources show increases in dysfunctional behavior during the peak of the commercial-whaling era and then again during the height of the fur trade. Drinking and violence seem to ebb when incomes decline. Recent evidence of the effects of employment during and just after World War II loosely supports these views. Although this evidence is not clear, it still can be assumed that onshore oil development has resulted in large cash flows that have led to significant social changes. These social changes on the North Slope are likely to have influenced the extremely high rate of suicide among the Inupiat (90.8 per 100,000 for the Inupiat versus 35 per 100,000 among the Yup'ik [Travis, 1989; USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003]).

In terms of cumulative effects, long-term effects could displace social systems; however, the NSB is vigilantly protecting the rights and culture of the Inupiat. Health and social services programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and NSB city governments cannot help as much now that they get less money from the State. Tribal, city, and the Borough governments in partnership may be able to provide programs, services, and benefits to residents. All communities in the NSB have banned the sale of alcohol for many years, but the possession of alcohol is not banned in Barrow, and many communities are continually under pressure to bring the issue up for a local referendum (NSB, 1998).

The relationship of oil and gas development to aberrant behavior and social pathologies might be seen more clearly in terms of social change and associations than in direct causality. Oil and gas development has affected all communities in Alaska and, for this reason, finding control communities is difficult; yet these impacts to communities are important to understand, and more cumulative effects studies need to be conducted. In a general sense, the accumulation of effect occurs as modernization occurs. As change happens, these alterations spread through the social fabric. Such change can be both negative and positive and can be measured to an extent with objective indicators of the opportunity structure or the stratification system such as education, income, occupation, social networks, and social mobility (created through income, education, etc.) (Cluck, 2000, pers. commun.).

Within this change, produced by the trends of modernization, the “rational choice” of individuals being affected by this change must be considered. Individuals make decisions, sometimes negative, sometimes positive, and stress or fear of change can reinforce a situation of internal conflict that can lead to negative social pathological effects. At the same time, positive impacts may come from higher incomes (e.g., ability to purchase better equipment for subsistence), better health care, and improved educational facilities. Yet what may be seen on the surface as having positive impacts at the same time may produce negative effects by producing a state of apathy toward or disinterest in older cultural norms known as anomie. An example of this would be an increased use of the Internet versus a reduction in listening to elders. Certain negative effects from social change are inescapable. As technology and opportunity develop, younger individuals readily accept these changes. This is easily seen in less developed countries where rapid change is evident or in the desertion of rural America by young people (Cluck, 2000, pers. commun.).

Both positive and negative impacts from oil and gas development exist in the NSB. Whether they are the more positive ones of increased funding for infrastructure or education or more negative ones associated with a lack of interest by younger people in traditional ways, both have added to social change. Oil and gas development has been one catalyst for such cumulative change on the North Slope; although it needs further study, it is not the single causal agent (Cluck, 2000, pers. commun.).

Stress created by the fear of an oil spill also is a distinct impact-producing agent within the human environment. Stress from this general fear can be broken down to the specific fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- the lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- the lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- the need to employ and work with lawyers in drafting litigation to attempt to stop proposed development (USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003).

4.4.1.13.4.1. Anticipated Effects From Disturbance. Potential effects on sociocultural systems from disturbance were discussed in Section 4.4.1.13.1.1. See also the general discussion on anticipated effects to sociocultural systems in Section 4.4.1.13.4 above.

Cumulative Past and Present Actions. Cumulative past and present actions related to vessel and aircraft disturbance effects on subsistence resources and practices were discussed in Section 4.4.1.12.4.1 and 4.2. These actions would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

4.4.1.13.4.2. Anticipated Effects From Discharges. Potential effects from discharges on subsistence resources and practices were discussed in Section 4.4.1.12.4.3. These actions would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

Cumulative Past and Present Actions. Cumulative past and present actions related to effects of discharges on subsistence resources and practices were discussed in Section 4.4.1.12.4.3. These actions would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

4.4.1.13.4.3. Anticipated Effects From Large Oil Spills. Potential effects on sociocultural systems from large oil spills were discussed in Section 4.4.1.13.1.2. See also the general discussion on anticipated effects to sociocultural systems in Section 4.4.1.13.4 above.

Cumulative Past and Present Actions. Cumulative effects from large oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.4.4 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

An ADF&G social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from outer continental shelf development. About 60% of the respondents did not believe a small oil spill could be contained or cleaned up, and 80% did not believe a large oil spill could be contained or cleaned up. An overall study on 21 Alaskan communities concluded that impacts from the EVOS on subsistence use and the social and cultural system that subsistence activities support persist to this day (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003).

Impacts in the first year following the spill included dramatic declines in harvest levels, reduced diversity of resources used, reduced sharing, and disruption in opportunity for young people to participate and learn the cultural values associated with subsistence. Fear of contamination of food resources was identified as a major factor in these reductions. In the following 3 years, harvest levels, sharing, and subsistence involvement rebounded, although not uniformly across and among communities. By 10 years after the spill, the authors conclude that subsistence uses largely have recovered to previous levels, but that some long-term changes remain, notably in fish species making up a larger portion of total subsistence, while marine mammals, marine invertebrates and birds are make up a smaller part than before the spill. Resource scarcity is now cited as the reason for changes rather than fear of contamination, cited just after the spill. Hunters also reported that additional effort is required to achieve desired harvest levels because some resources are more scarce (Fall and Utermohle, 1999). The Impact Assessment, Inc. study adds additional consideration of psychological and identity impacts from the spill. These authors emphasize that for Alaskan Natives, the early impacts of the spill were compounded by the sense of “fear” about resource safety and the “alienation” from culturally valued activities this caused. These authors also note that continuing litigation contributes to continuing psychological impacts of the spill (Impact Assessment, Inc., 2001). While their report does not include new data from the 10-year, postspill time period, some of the reported impacts would have been mitigated by the general recovery in subsistence harvest practices (USDO, MMS, 2003a; USDO, BLM and MMS, 2003).

A study by Picou et al. (1992) showed that 18 months following the EVOS, residents of Cordova had experienced long-term negative social effects—disruption to work roles and increased personal stress. Additionally, they observed that:

work disruption was correlated with intrusive stress and fishermen experienced more work disruption than other occupations. It may be possible that other natural resource community activities such as participation in subsistence harvests may identify subpopulations more vulnerable to long-term negative social impacts. (Picou et al., 1992)

Another good source of information on spill effects is *the Social Indicators Study of Alaskan Coastal Villages, Volume VI: Analysis of the Exxon Valdez Spill Area, 1988-1992* (Human Relations Area Files, Inc., 1994). The summary of findings section affirmed that immediately after the spill and continuing into early 1990, Native people decreased their harvests of wild resources and relied on preserved foods harvested before the spill. By winter 1991, the Natives’ normal harvesting activities had begun to resume, but the proportions of wild foods in their diets remained below those of 1989. The study also demonstrated in its analysis that non-Natives and Natives “define the environment and resources within the environment very differently. Commodity valuation takes precedence” for non-Natives and “instrumental use and cultural and spiritual valuation take precedence” for Native people (Human Relations Area Files, Inc., 1994).

4.4.1.13.4.4. Anticipated Effects From Small Oil Spills. Anticipated effects from small oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.4.5. See also the discussion on anticipated effects to sociocultural systems from large oil spills in Section 4.4.1.13.4.3 above.

Cumulative Past and Present Actions. Cumulative effects from small oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.4.5 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

4.4.1.13.4.5. Anticipated Effects From Oil-Spill Response and Cleanup. Potential effects on sociocultural systems from oil-spill response and cleanup were discussed in Section 4.4.1.13.1.3. See also the general discussion on anticipated effects to sociocultural systems in Section 4.4.1.13.4 above.

Cumulative Past and Present Actions. Cumulative effects from oil-spill response and cleanup on subsistence resources and practices were discussed in Section 4.4.1.12.4.6.

If a large oil spill occurred, cleanup activities for an offshore spill $\geq 1,000$ bbl occurring over the life of the field and elsewhere could generate many cleanup and response jobs. Based on the EVOS, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs. In the event of a much larger spill, these dramatic changes could cause tremendous social upheaval (Human Relations Area Files, Inc., 1994a,b,c; ADF&G, 1995a; Impact Assessment, Inc., 1990c, 1998). Many North Slope village men have been trained in cleanup procedures and have said they want to be part of any cleanup response (Lampe, 1999). The NSB would play a large part in structuring any spill response and cleanup (*North Slope Subarea Contingency Plan*, EPA, U.S. Coast Guard, and ADEC, 1999; USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003).

4.4.1.13.4.6. Anticipated Effects From Seismic Surveys. Potential effects from seismic surveys on sociocultural systems were discussed in Section 4.4.1.13.1.4.

Cumulative Past and Present Actions. Cumulative effects from seismic surveys on subsistence resources and practices were discussed in Section 4.4.1.12.4.7 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

If seismic activities occur with the magnitude proposed, cumulative impacts to social organization and cultural values, such as stress on social systems due to changes in population and employment, are not expected to occur; on the other hand, potential major impacts could result from changes to subsistence-harvest patterns. Such potential cumulative effects on subsistence-harvest patterns would affect Inupiat social organization through disruptions to kinship ties, sharing networks, task groups, crew structures, and other social bonds.

4.4.1.13.4.7. Anticipated Effects From Habitat Loss. Potential effects from habitat loss on sociocultural systems and practices were discussed in Section 4.4.1.13.1.5.

Cumulative Past and Present Actions. Cumulative effects from habitat loss on subsistence resources and practices were discussed in Section 4.4.1.12.4.8 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

4.4.1.13.4.8. Anticipated Effects From Onshore Development. Potential effects from onshore development on sociocultural systems were discussed in Section 4.4.1.13.1.6.

Cumulative Past and Present Actions. Cumulative effects from onshore development on subsistence resources and practices were discussed in Section 4.4.1.12.4.9 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

Onshore, from the expansion of the Alpine field, minimal employment of Nuiqsut, Barrow, Atqasuk, and Kaktovik residents during construction and operation is expected, and no change in population growth rate is expected (USDOJ, BLM, 2004).

Additionally, new pipelines might change local subsistence use and potentially could increase competition for subsistence resources by providing access for other user groups. Pipelines and roads can deter subsistence users from using traditional harvest areas and encourage them to use different areas. The cumulative effects from the construction and operation of new offshore platforms, pipelines, pipeline landfalls, shore bases, causeways, docks, and processing and waste facilities also could disrupt but not

displace local uses; the scope of this disruption would depend on the extent of meaningful local consultation in project design and location and in the development of appropriate mitigation measures (USDOJ, MMS, 2007c).

Effects of nonoil and gas activities on sociocultural patterns would occur from a greater amount of scientific research and data collection undertaken prior to NPR-A lease sales and as part of Federal land-management responsibilities. These research efforts and associated aircraft use could cause temporary and localized diversion or deflection of subsistence species. More overland moves could be required to support scientific and other activities in the areas newly available for leasing. Several Inupiat families from Atqasuk, Barrow, and Nuiqsut use cabins, camps, caches, and other sites along the coast and inland to Teshekpuk Lake for subsistence activities. The area also is an important route for residents who travel by snowmachine between Barrow, Atqasuk, and Nuiqsut for social, subsistence, and employment reasons. Continued use of this area helps maintain family connections and a feeling of relatedness and stability, which could be impeded or reduced by increased activity if these areas are opened to oil and gas development. Nevertheless, effects from nonoil and gas activities are expected to be temporary and localized, and are unlikely to affect overall sociocultural patterns (USDOJ, BLM, 2005).

4.4.1.13.4.9. Anticipated Effects from Production Activities. Potential effects from production activity on sociocultural systems were discussed in Section 4.4.1.13.1.7.

Cumulative Past and Present Actions. Cumulative effects from production activity on subsistence resources and practices were discussed in Section 4.4.1.12.4.10 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices. See onshore effects discussion above in Section 4.4.1.13.4.8.

4.4.1.13.4.10. Anticipated Effects from Climate Change. Potential effects from climate change on sociocultural systems were discussed in Section 4.4.1.13.1.8.

Cumulative Past and Present Actions. Cumulative effects from climate change on subsistence resources and practices were previously discussed in Section 4.4.1.12.4.11 and would be expected to impact sociocultural systems to the extent they adversely impacted subsistence harvests and practices.

Because of rapid and long-term impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope communities would experience significant and long-term cultural stresses in addition to major impacts on population, employment, and local infrastructure. If subsistence livelihoods are disrupted, communities in the Arctic could face increased poverty, drug and alcohol abuse, and other social problems. As stated by Parson et al. (2001): “It is possible that projected climate change will overwhelm the available responses. It is also realistic to expect that some general assistance could be found to mitigate the losses of nutrition, health, and income from diminished subsistence resources, but such assistance would likely have little effect in mitigating the associated social and cultural impacts” (Langdon, 1995; Peterson and Johnson, 1995; National Assessment Synthesis Team, 2000; IPCC, 2001b; Callaway et al., 1999; ARCUS, 1997; USDOJ, MMS, 2006a,b, 2007c).

Changes in climate regimes could result in changes to species diversity, numbers and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape that could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability); subsistence-harvest

practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations); and the traditional diet could be expected (Johannessen et al., 1999; IPCC, 2001b; NRC, 2003a; USDO, MMS, 2006a,b, 2007c).

If the landscape becomes less hospitable for human occupation, people may move to new locations on the North Slope, leave the area for either urban Alaska or High Arctic Canada, or adapt to the new conditions with a combination of reduced subsistence resources and increased dependence on outside sources of food and supplies. Community stresses could increase as a result, and traditional knowledge of the landscape, environment, and resources would be devalued if conditions change rapidly, reducing the influence of experienced elders in the communities. Reduced levels of stratospheric ozone could continue to allow higher levels of UV exposure to northern peoples, lowering immune system function and increasing the likelihood that residents would suffer increased incidences of skin cancer and cataracts (ACIA, 2004; USDO, BLM, 2005).

4.4.1.13.5. Traditional Knowledge on Cumulative Effects to Sociocultural Systems.

Traditional knowledge relating to cumulative effects on subsistence resources and practices was discussed in Section 4.4.1.12.5. Traditional knowledge relating to individual impact effects on sociocultural systems was discussed in Section 4.4.1.13.3.

Sarah Kunaknana, a Nuiqsut elder, and others in the communities have noted a growing divide in the communities that originates in the uneven distribution of benefits and costs from oil and gas exploration and development (NSB, 2004). Nuiqsut residents have been impacted by industrial activity near the community but do not feel that they have received a proportional amount of impact funds or other compensation (USDO, BLM, 2005).

Residents stated during scoping for the Northeast NPR-A Amendment lease sale that the proposed lease stipulations and ROPs would be more permissive to lessees, would not sufficiently protect subsistence-use areas or resources, and would diminish what local residents consider to be the BLM's trust responsibilities in supporting and maintaining subsistence uses in the planning area. In their view, BLM would be shifting the responsibilities for enforcing the lease stipulations and ROPs to other local, State, and Federal agencies (Ahmaogak, 2003, Napageak, 2003, NSB, 2004; USDO, BLM, 2005).

Areas specifically protected under the 1998 Northeast NPR-A IAP/EIS Record of Decision (ROD) would be made available for oil and gas leasing and development. The possibility that important subsistence-use areas would be developed and, thus, placed off limits to other land users, has caused increased anxiety for residents of Nuiqsut, Barrow, and Atqasuk. Residents noted during scoping for this amendment EIS that existing lease stipulations had not been in effect long enough to be adequately tested, and that the provisions of the 1998 Northeast IAP/EIS ROD have not prevented ConocoPhillips from applying for, and BLM from considering, development in the Fish Creek Setback as part of the Alpine Satellite Development Plan (USDO, BLM, 2005).

Commenters on this amendment stated that the granting of exceptions to the lease stipulations and ROPs was a factor undermining the credibility of the proposed Amended IAP/EIS. The consultation period leading to the 1998 Northeast IAP/EIS ROD, while long by BLM standards, was noted by local residents as being a "rushed" 18-month program with no power on the part of the communities to reject or veto any particular course of action (NSB, 2004). Local residents felt that instead of being consulted, they were being "informed" by BLM, which did not build confidence on the part of the communities, and reinforced their feelings of being powerless to oppose changes being imposed by outside agencies and industry (NSB, 2004). As a result, some residents regard any effort to participate in consultation or other management processes as futile. This can create a feedback loop of decreased participation; decreased interest in cooperation with agencies; and increased conflict between agencies, lessees, and local resident

groups as evidenced in scoping transcripts for 30 years of hearings held on the North Slope (USDOJ, BLM, 2005).

Rosemary Ahtuanguak, former mayor of Nuiqsut, testified in 2001 hearings held for the Liberty Project:

One of the biggest issues that affects our community is the loss of control. In addition to the loss of subsistence opportunities, the major severe impacts result from the petroleum development in other areas of the Arctic. It is the lack of control over these events experienced by the village. Nuiqsut residents state they are the last to find out what's happening to them. They are never asked or generally considered about the pattern or course of the industry's development. They are merely informed after major decisions are in place. They would not spend the money making these studies if they were not planning to develop them. So it's a moot issue, after the fact. You're coming for the meeting, but you're already spending the money because you know this project is happening. This perception causes enormous social stress and tension. It is reflected in the increased community social ills, such as the alcoholism, the domestic violence, and the drug abuse. Thus, existing and potential activities further exacerbate and destabilize stress and tension resulting from almost 20 years of petroleum activities in the region. And since development would complete the pattern surrounding our traditional whaling site, it poses the most significant and long-term adverse social and cultural impacts of all the development of the North Slope, the potential for permanent reduction and/or loss of subsistence reserves, and thus, the viability of the Iñupiat way of life. (USDOJ, BLM, 2005)

Rosemary Ahtuanguak testified again during scoping for the Alpine Satellite Development Plan EIS (USDOJ, BLM, 2004a):

When I started as a health aide in 1985 I had one asthma patient. By the time I went to the University of Washington for my physician assistant certificate in 1989, I had 20 to 25. When I came back in '91, there were 35. When I quit in 2000, there were over 60. The village make-up has not changed; it is still mostly Inupiaq. What was contributing, the most overwhelming issue, was that oil development around the community had increased and gotten closer. The worst nights on call were nights with many natural gas flares occurring. We could see it in the flares or in the fields around us. They release particles and they travel to us. The chance of an inversion will affect us. An inversion is a bowl-like air trap with cold air trapped by warm air. Increased concentrations of particulate matter occurs during these episodes. (USDOJ, BLM, 2005)

4.4.1.13.6. Direct and Indirect Effects Under Alternative 1.

Conclusion. There would be no direct or indirect impacts to sociocultural systems in the project area from Lease Sales 209 or 217 if they were not held.

4.4.1.13.7. Cumulative Effects Under Alternative 1.

The contribution of OCS activities effects on subsistence resources and practices were discussed in Sections 4.4.1.12.7, and the same activities would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices.

Summary. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from small changes in population and employment, seismic-survey disturbance, onshore actions, and periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup. Effects from these sources are not expected to displace ongoing sociocultural systems, but community activities and traditional practices for harvesting, sharing, and processing

subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales from an oil spill (USDOJ, MMS, 2003a).

Offshore exploration and development in the Beaufort seas is expected to increase, with lease sales planned for the near future by MMS and the State of Alaska in this offshore area. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk might result from seismic-exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of people and equipment for seismic exploration. However, the possible long-term deflection of whale migratory routes or increased skittishness of whales due to seismic-survey activities in the Beaufort Sea might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude proposed has not been approached in the region since the 1980s (USDOJ, MMS, 2006a; USDOJ, BLM, 2005).

While it is unknown exactly how much of the offshore area will be leased in these future sales, several ship-based exploratory seismic operations have been conducted during the open-water season in 2006 and 2007, resulting in conflicts with marine mammal hunters and concerns over the fall whaling harvest. Should offshore activity lead to a considerable decrease in success in fall whaling, it would contribute to major negative effects to the North Slope Iñupiat peoples' identity and could have culturewide effects (USDOJ, BLM, 2005).

Onshore, continuing oil and gas leasing and development, as well as ongoing changes in the arctic climate, will have impacts on Iñupiat sociocultural systems in the foreseeable future. Development is being considered for the Northeast NPR-A corner of the planning area for Alpine Field Satellites development, and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development. This problem could be exacerbated if gas development caused development to extend into the foothills of the Brooks Range. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization potentially could occur as a result of changes in population, employment, subsistence harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities potentially could result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities (USDOJ, BLM, 2005).

Overall, cumulative impacts to the sociocultural characteristics of North Slope communities could lead to changes to community structure, cultural values and community health and welfare—changes that actually predate oil and gas development on the North Slope. However, change in community sociocultural characteristics has continued during the period of oil development. As the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atkasuk depend on the subsistence caribou harvest from the CAH and TCH [Teshekpuk Lake Herd]; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns (including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources), social bonds, and cultural values (USDOJ, BLM, 2004; USDOJ, MMS, 2006b).

Onshore, the abandonment of oil fields and the related loss of revenue no doubt would have serious effects on the entire State of Alaska. However, the collapse of commercial enterprise is seen as inevitable and is common over the history of the Iñupiat. Commercial whaling served the same markets as

petrochemicals do today, and the Iñupiat survived by returning to the land. Fur trapping collapsed and the Iñupiat people adapted. Based on this historic demonstration of their resiliency, it would appear that the Iñupiat may be at less risk from the decline of industry than they are in the face of an expanding and unchecked industry. Nevertheless, worldwide data suggest a consistent pattern of marked increases in stress, social problems, and emigration under circumstances of sudden or severe economic depression. Data from Inupiat populations has shown that economic depression correlates strongly with epidemic rates of suicide (Travis, 1984). In the event of oil-field abandonment, the Iñupiat would likely be employed to assist in the removal and demobilization of the infrastructure, while at the same time continuing their subsistence pursuits (USDOJ, BLM, 2005).

Additionally, areas of importance to subsistence users, including areas surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, could be impacted by oil and gas activities and could increase anxiety in Nuiqsut, Barrow, and Atkasuk (USDOJ, BLM, 2005).

We may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The NSB already is experiencing problems in the social health and well-being of its communities, and additional development, including offshore oil development on the North Slope, would further disrupt them. Health and social-service programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and NSB city governments cannot help as much now that they get less money from the State. Based on experiences after the EVOS, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs (USDOJ, MMS, 2006b).

Not all sociocultural changes are negative. It is anticipated that there will be a doubling of the population on the North Slope by the year 2040. As long as core Iñupiat values continue to be passed from generation to generation, as they currently are, an increase in the Iñupiat population results in a strengthening of the culture as a whole. At the same time, revenues from NSB taxation on oil development produce positive impacts come from higher incomes, better health care, improved housing, and improved infrastructure and educational facilities, although these impacts may primarily benefit younger individuals who are generally more accepting of change (NRC, 2003a). Iñupiat culture as an adaptive mechanism is a powerful means of self-directed social, political, and cultural change capable of sustaining the Iñupiat through adverse circumstances, as it has for centuries guided them through resource shortages, inter- and intragroup social conflicts, and environmental changes (USDOJ, BLM, 2005).

Health issues caused by persistent and short-term pollution could shorten lifespans of elders, who are the key repositories of traditional and cultural knowledge in the communities. Health issues from increased injuries as a result of the need to travel further over rough terrain to support families with subsistence foods could reduce community involvement with employment, tax the community health infrastructure, encourage outmigration, and lead to increases in substance abuse and depression in those no longer able to participate in subsistence activities. Cuts in funding for services would increase the severity of the problem of delivery of health services, as well as maintaining health and hygiene infrastructure (e.g., freshwater, sewers, and washeteria) (USDOJ, MMS, 2006b). See also the human health discussions in the Environmental Justice analysis in Section 4.4.1.15.

Any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. Although onshore and offshore cumulative effects are difficult to separate, most cumulative effects are thought to result from onshore development. To date, no comprehensive onshore

monitoring or baseline data gathering has ever been undertaken by responsible Federal and State agencies and industry; the most obvious cumulative effects have occurred and continue to occur onshore, as oil-field development expands westward from the initial Prudhoe Bay/Deadhorse area of development. Proposed and ongoing studies that will contribute to a more comprehensive understanding of cumulative and human health effects to the Native population of the North Slope are discussed in the Environmental Justice cumulative effects analysis Section 4.4.1.15.8 (USDOJ, MMS, 2006b); for a general discussion of Environmental Justice, see Section 4.4.1.15.

Conclusion. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from oil exploration and development activities, from changes in population and employment, and subsistence-harvest patterns; accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources. However, such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion); social organization; or sociocultural systems (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2006b).

In this cumulative analysis, the level of effects would increase because collectively, activities would be more intense. More air traffic and non-Natives in the North Slope region could increase interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow, Atkasuk, and Kaktovik (USDOJ, MMS, 2003a).

For 2D and 3D seismic surveys in the Beaufort Sea region, effects to sociocultural systems are expected to be minimal. Effects to social well-being (social systems) would be noticeable because of concern over deflection of the bowhead whale due to seismic-survey activities and the attendant effects on the subsistence harvest. These concerns may translate into greater activity as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If the deflection actually occurs, effects could be major (USDOJ, MMS, 2007d).

At the regional level, offshore effects to sociocultural systems from routine activities from exploration, development and production, and decommissioning (abandonment), would cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level—a moderate effect. At the local level, effects from routine development could exceed a major level of effect. Additionally, effects from a large oil spill would exceed a major level of effect, because noticeable disruption in excess of 2 years could occur from a large spill when combined with cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns. State and Federal mitigation measures should prove effective in ameliorating many of the cumulative effect discussed. Social systems will successfully respond and adapt to the change brought about by the introduction of these activities. If development and production occur, the accommodation response in itself could represent major impacts to social systems (see USDOJ, MMS, 2007d).

On and offshore, as the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atkasuk depend on the subsistence caribou harvest from the CAH and the TCH; additional future

development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns, including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources; social bonds; and cultural values. If oil and gas development occurs near the north shore of Teshekpuk Lake and is connected by roads and pipelines to the Alpine field, an important subsistence-use area used by residents of Nuiqsut, Barrow, and Atkasuk could be avoided by subsistence users. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence-resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment (USDOI, BLM, 2004; USDOI, BLM and MMS, 1998).

Industrialization clearly displaces subsistence users from traditional use areas, even if no legal impediments to access are imposed (NSB, 2003). Essentially, potential effects include disturbance of traditional use and archaeological sites, such as hunting, fishing, and whaling camps, by construction and the increased possibility for vandalism. Any effects to these resources would have a corresponding and proportional effect on cultural value. If development occurred in areas containing concentrations of subsistence cabins, camps, and traditional use sites, and subsistence resources experienced only minor impacts, subsistence users would be displaced and impacts would be expected to be far greater. The BLM expects its subsistence stipulations to mitigate potential exploration and development conflicts with subsistence cabins, camps, and use sites (USDOI, BLM and MMS, 2003; USDOI, MMS, 2007c).

Cumulative effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from on- and offshore exploration, development, and production activities; small changes in population and employment; and disruption of subsistence-harvest patterns from seismic-noise disturbance, oil spills and oil-spill cleanup, and climate change. Disturbance effects periodically could disrupt but not displace ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. However, if a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (USDOI, MMS, 2003a, 2006b; USDOI, BLM and MMS, 2003).

If a large spill contacted and extensively oiled coastal habitat, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Such impacts would be considered major. All subsistence whaling communities and other communities that trade for and receive whale products and other resources from the whaling communities could be affected. A large spill anywhere within the habitat of bowhead whales or other important marine mammal subsistence resources could have multiyear impacts on the harvest of these species by all communities that use them. In the event of a large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. In addition, harvests could be affected by the IWC, which could decide to limit harvest quotas in response to a perceived threat to the bowhead whale population (USDOI, MMS, 2003a, 2006b; USDOI, BLM and MMS, 2003).

Beyond the impacts of a large spill, long-term deflection of whale migratory routes or increased skittishness of whales due to increasing seismic surveys and industrialization in the Beaufort Sea would make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated although a predominant concern continues to be potential disruption associated from seismic-survey noise on subsistence-harvest patterns, particularly on the bowhead whale—a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks,

subsistence task groups, and crew structures, as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Such disruptions could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems (USDOJ, MMS, 2006a).

Onshore, because Nuiqsut is relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community, a major effect; however, overall effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. This same potential exists for the communities of Barrow, Atkasuk, and Kaktovik as Beaufort Sea areawide leasing, exploration, and development proceeds on- and offshore. Any potential effects to subsistence resources and subsistence harvests and consequent impacts on sociocultural systems are expected to be mitigated substantially, though not eliminated (USDOJ, MMS, 2003a, 2004, 2006b).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and, considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses, as well as impacts to population, employment, and local infrastructure. The termination of oil activity could result in the outmigration of non-Inupiat people from the North Slope, along with some Inupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally constrained, postoil-production environment. If subsistence livelihoods are disrupted, Inupiat communities could face increased poverty, drug and alcohol abuse, and other social problems resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on non-subsistence foods (Langdon, 1995, Peterson and Johnson, 1995, National Assessment Synthesis Team, 2000, IPCC, 2001b).

As stated by Parson et al. (2001): “It is possible that projected climate change will overwhelm the available responses.” It also is realistic to expect that some general assistance could be found to mitigate the losses of nutrition, health, and income from diminished subsistence resources, but such assistance likely would have little effect in mitigating the associated social and cultural impacts. If present rates of climate change continue, impacts to subsistence resources and subsistence harvests—and consequent impacts on sociocultural systems—would be expected to be major (USDOJ, MMS, 2006b, 2004).

4.4.1.14. Archaeological Resources.

Summary. The greatest cumulative effect on archaeological resources in the Beaufort and Chukchi Sea region is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area. Accidental oil spills would affect onshore archaeological sites the most, but past cleanups have shown us that spilled oil had little direct effect on archaeological resources (Bittner, 1993). Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Various mitigation measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991). Although archaeological resources are not renewable, they are not affected directly or cumulatively by oil spills, the build up of toxic substances, noise, or air pollution. Effects are minimized due to modern technologies and practices that reduce the impact to the environment and therefore to archaeological resources (no thawing of permafrost, restricted personnel access, wintertime operations, small-footprint drilling and transportation technologies).

Furthermore, mitigating measures, such as offshore high resolution seismic surveys with archaeological analyses in zones of potential resources, and onshore archaeological surveys where offshore pipelines make landfall, would avoid damage or destruction of potential archaeological resources. Cumulatively, oil and gas projects in the region likely would disturb the seafloor, but remote-sensing surveys made before approval of any Federal or State lease actions should keep these effects low. Federal laws would preclude effects to most archaeological resources from these planned activities.

Archaeological resources in the Alaska Region that may be impacted by regional oil and gas activities include historic shipwrecks, aircraft, and inundated prehistoric sites offshore and historic and prehistoric sites onshore. Archaeological sites along the present shoreline, in shallow nearshore waters, and along shallow bathymetric highs, have a high likelihood of having already been severely impacted by ice gouging. Shipwrecks in deeper water, beyond the areas of severe ice gouging, such as in the deeper waters off Point Barrow or in the Chukchi Sea, have a chance of survival. Likewise, prehistoric archaeological sites that have been buried by a sufficient amount of sediment may be protected from the effects of ice gouging, winter storms, and current scour (USDOJ, MMS, 2007c).

Routine activities associated with regional oil and gas activities that are likely to affect archaeological resources include well drilling, platform installation, and pipeline installation, as well as onshore facility and pipeline construction projects that involve ground disturbance. While the source of potential impact will vary with the specific location and nature of operations, the goal of archaeological resource management remains the protection and/or retrieval of unique information contained in intact archaeological deposits (USDOJ, MMS, 2007c).

Regulations at 30 CFR 250.194 allow the MMS Regional Director to require an archaeological report based on geophysical data be prepared, if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision is based on whether a historic shipwreck is reported to exist within or adjacent to a lease area. For prehistoric resources, an analysis is completed prior to each lease sale that considers the relative sea level history, the depth of burial of the late Wisconsin land surface, the type and thickness of sediments burying the old land surface, and the severity of ice gouging at the present seafloor. Lease areas that are shown by this analysis to have the potential for prehistoric archaeological resources are required to have an archaeological survey prior to initiating exploration and development activities. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine if an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, the MMS procedures require consultation with the State Historic Preservation Office to develop mitigating measures prior to any exploration or development. It is assumed for this analysis that the level of protection provided by the regulation is in place (USDOJ, MMS, 2007c).

Federal State, and local laws and ordinances, including the National Historic Preservation Act, the Archaeological Resources Protection Act, and the Alaska Historic Preservation Act, protect known sites and also as-yet-unidentified archaeological resources. Existing regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. Therefore, most archaeological resources will be located, evaluated, and mitigated prior to any onshore construction. New data related to the human history and prehistory of Alaska likely will be produced from compliance-related archaeological projects (USDOJ, MMS, 2007c).

Effects Definitions and Effects Levels.

A negligible effect: little damaging interaction occurs between an effect-producing agent and an archaeological site.

A minor effect: an interaction occurs between an archaeological site and an effect-producing agent and effects are temporary and reversible or results in the loss of archaeological data that are not significant.

A moderate effect: an interaction occurs between an archaeological site and an effect-producing agent and results in the loss of significant, but not unique, archaeological data.

A major effect: an interaction occurs between an archaeological site and an effect-producing agent and results in the loss of unique archaeological data.

4.4.1.14.1. Potential (Unmitigated) Effects to Archaeological Resources.

4.4.1.14.1.1. Potential Effects from Disturbance. Physical disturbance of resources could damage or destroy buildings, shipwrecks, sites, or artifacts, or cause a loss of site context with resulting loss of archaeological data or artifacts. Archaeological resources are nonrenewable. Archaeological surveys conducted before any activity onshore or offshore will identify potential resources, and they will be avoided or detrimental effects mitigated (USDOJ, MMS, 2007d).

All development drilling, constructing, and mining activities, similar to those noted for exploration, have the potential to affect prehistoric and historic archaeological resources. Development activities increase the potential for effects, because they are more frequent, more concentrated, and last longer. In addition, development would require the construction of pipelines offshore and onshore (USDOJ, MMS, 2007d).

Activities that have the potential to disturb offshore archaeological resources include:

- anchoring;
- pipeline trenching;
- excavating of well cellars;
- emplacement of bottom-founded platforms; and
- use of ocean bottom cables for seismic data collection.

The placement of a bottom-founded production platform might compress Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata, including potential prehistoric archaeological resources. These types of disturbances could affect the seafloor and shallow subsurface, where archaeological resources are most likely to occur. Prehistoric archaeological resources may exist in areas where water depths are <60 m and that have sufficient sediment cover to have protected sites from the effects of marine erosion and ice gouging. Prehistoric archaeological resources are not expected in areas where water depths exceed 60 m, because these areas of the continental shelf would have become submerged by rising sea level prior to 13,000 years Before Present (B.P.). Archaeological analysis of shallow geologic and marine geophysical survey data would identify any areas with possible archaeological resources, which would be avoided or potential effects mitigated before any activities would be permitted.

Any offshore activity that disturbs the seafloor in water depths <60 m in areas not identified as having high-density ice gouging, has the potential to affect prehistoric and historic shipwreck archaeological resources. Any activity that disturbs the seafloor in water >50 m has the potential to affect historic

resources such as shipwrecks, abandoned relics of historical importance, or airplanes. It is not only the intensity of ice-gouging evident at the seafloor, but the depth to which sediments have been reworked by ice gouging that is important. If the Holocene sediments are thick enough in an area (and this would be especially true where Holocene sediments are infilling a relict Pleistocene channel feature) prehistoric sites may have survived intact, regardless of the severity of ice-gouging at the seafloor. This can only be determined after a high-resolution seismic survey is conducted of the area.

In the Chukchi Sea Planning Area, pipeline construction in the area of Peard Bay and seaward in a northerly direction could disturb historic shipwreck resources where accounts have identified five whaling barks wrecked since 1871, two steam whalers wrecked in 1897, and another steam freighter wrecked in 1924. In the Beaufort Sea Planning Area, pipeline construction seaward west or east of Barrow could disturb historic shipwreck resources where accounts have identified eleven whaling barks and ships wrecked since 1876.

Prehistoric archaeological sites could be affected by activities that disturb the surface or shallow subsurface area. Such activities include:

- Removal of conductor casing (about 1 m in diameter), which extends from the surface down to depths of 75-100 m and disturbs all soil inside the casing;
- Constructing a gravel pad or year-round road construction that removes soil layers or causes shallow permafrost to thaw;
- Gravel mining, particularly along the trend of paleo-riverbanks or buried overbank deposits;
- Emplacement of bottom-founded platforms that may compress Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata. Drillship anchors may disturb host or overlying sediment, as well (USDOJ, MMS, 2007d).

Bottom-founded structures could damage or disturb potential shallow archaeological resources, if dragging and sliding of the base-plate or skirt occurs on the seafloor when the structure is set down or removed. Penetration of the skirt could occur to a depth of approximately 2 m. However, geophysical and archaeological surveys would identify any such resource before the platform is moved and the resource would be avoided or potential effects would be mitigated.

Floating drilling platforms could disturb the sea floor and buried archaeological resources by anchor-drag during the setting of anchors or movement of the drillship or support vessels over the anchor-spread area. In addition, floating drilling platforms require the excavation of a well cellar for burying of the blowout preventor stack beneath the seafloor surface, which could affect an archaeological site.

Activities that could damage previously unidentified onshore archaeological resources include:

- installation of rigs for extended-reach drilling;
- construction of gravel pads;
- year-round roads;
- pipeline construction and installation;
- gravel mining; and
- oil-spill-cleanup activities in the unlikely event that a large spill occurs.

Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Any activity that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. We assume that onshore pipelines would be elevated with vertical support members (pilings). These probably would disturb $2 \text{ ft}^2 (0.2 \text{ m}^2)$ of soil to a depth of several tens of feet (tens of meters), but could penetrate soil horizons of potential archaeological significance. Any archaeological site beneath or

near the pipeline right-of-way has the potential for being disturbed by the construction of roads and the installation of pipelines. Road construction has the potential to disturb archaeological sites through the removal of potential layers containing site deposits, or by thawing of shallow permafrost. Increased human activities in an area increase the potential for vandalism (USDOJ, MMS, 2007d).

Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the Defense Early Warning (DEW) system could be affected by increased human activity and construction in remote areas and the increased possibility for vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism.

4.4.1.14.1.2. Potential Effects from Oil Spills, Oil-Spill Response, and Cleanup. Oil spills and their subsequent cleanup could impact archaeological resources directly and/or indirectly.

Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil also may contaminate organic material used in C^{14} dating and, although there are methods for cleaning contaminated C^{14} samples, greater expense is incurred (Dekin et al., 1993). However, many other anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution should always be taken when analyzing radiocarbon samples from coastal Alaska (see Reger, McMahan, and Holmes, 1992).

The greatest effects to onshore archaeological sites would be from cleanup activities resulting from accidental oil spills. The most important understanding from past cleanups of large oil spills is that the spilled oil usually did not directly affect archaeological resources (Bittner, 1993). A State University of New York at Binghamton study evaluated the extent of petrochemical contamination of archaeological sites as a result of the *Exxon Valdez* oil spill; it examined the effects of the spill on archaeological deposits and found that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure. Researchers concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion, but that fewer than 3% of the resources would suffer significant effects (Dekin et al., 1993).

The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high-pressure washing on or near archaeological sites pose risks to archaeological resource. Exposure of undocumented sites increases the possibility of vandalism. Increased human presence and activity increases the potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. The discovery and reporting of archaeological sites during cleanup activities also would result in their being documented and protected. Unauthorized collecting of artifacts by cleanup-crew members also is a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1993) described in her summary of the 1989 *Exxon Valdez* oil spill: “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself.” Effects of an oil spill on offshore archaeological resources would be minimal and limited to activities associated with oil-spill-response support vessels such as anchoring.

Protection of an archaeological resource during an oil spill requires specific knowledge of the resource’s location, condition, nature, and extent prior to impact. However, large portions of the Alaska Region coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency

response (Wooley, Hillman, and O'Brien, 1997), these data have not been compiled for all areas of the Alaska Region. Subarea plans for the North Slope, Cook Inlet, and Prince William Sound reference procedures for addressing and mitigating potential impacts to archaeological resources should an oil spill occur (Alaska Regional Response Team, 2000).

4.4.1.14.1.3. Potential Effects from Seismic Surveys. Potential Ocean-Bottom Cable (OBC) surveys in the Beaufort Sea Planning Area could be used to acquire seismic-survey data in water that is too shallow (≤ 14 m) for the data to be acquired using marine streamers and too deep to have bottomfast ice in the winter, which would allow over-ice winter operations. It is possible that cables would be laid in water deeper than 14 m, if the deeper water data were part of a larger acquisition program that went from shallow to deeper water. The OBC surveys require the use of multiple ships (usually two ships for cable layout/pickup, one for recording, one for shooting, and two smaller utility boats). These vessels generally are smaller than those used in streamer operations, and the utility boats are quite small.

Operations begin by dropping cables off the back of the layout boat. Cable length is typically 4,200 m but can be up to 12 km. Groups of seismic detectors (usually hydrophones and vertical motion geophones) are attached to the cable in intervals of 25-50 m. Multiple cables are laid on the seafloor parallel to each other using this layout method, with a 50- to 100-m interval between cables. When the cable is in place, a ship towing a dual airgun array passes between the cables, firing every 25 m. Sometimes a faster source ship speed of 6 kn instead of the normal 4.5-kn speed is used, with an increase in time between airgun firings.

After a source line is shot, the source ship takes about 10-15 minutes to turn around and pass down between the next two cables. When a cable is no longer needed to record seismic data, it is retrieved by the cable-pickup ship and moved to the next recording position. A particular cable can lie on the bottom anywhere from 2 hours to several days, depending on operation conditions. Normally, a cable is left in place about 24 hours; however, cables left on the bottom during storms sometimes can work into the substrate before they can be recovered. The OBC surveys might occur in the Beaufort Sea but are not anticipated to occur in the Chukchi OCS because of its great water depths and the greater efficiency of streamer operations in deepwater.

The OBC seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water as part of one program. The OBC activities could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' G&G Permit Stipulation 6 (regarding the discovery of archaeological resources) and CFR 251.6 (a)(5) regarding G&G Explorations of the Outer Continental Shelf to not "disturb archaeological resources," most impacts to archaeological resources in shallow offshore waters of the Beaufort Sea Planning Area would be avoided. Therefore, no impacts or only minor impacts to archaeological resources are anticipated.

4.4.1.14.1.4. Potential Effects from Onshore Development. Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to, or complete destruction of, information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have resulted from onshore construction activities prior to enactment

of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify (USDOI, MMS, 2007c).

Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Any activity that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. We assume that onshore pipelines would be elevated with vertical support members (pilings). These probably would disturb <2 ft² (0.2 m²) of soil to a depth of several tens of feet (tens of meters), but could penetrate soil horizons of potential archaeological significance. Any archaeological site beneath or near the pipeline right-of-way has the potential for being disturbed by the construction of roads and the installation of pipelines. Road construction has the potential to disturb archaeological sites through the removal of potential layers containing site deposits, or by thawing of shallow permafrost. Increased human activities in an area increase the potential for vandalism (USDOI, MMS, 2007d).

Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the DEW system could be affected by increased human activity and construction in remote areas and the increased possibility for vandalism. Prehistoric sites also might be subjected to increased vandalism.

4.4.1.14.2. Mitigation Measures. Standard MMS G&G Permit Stipulations have provisions for the protection of archaeological resources. Except as approved on a case-by-case basis, lessees may not set a drilling or production facility on location until MMS has approved an exploration plan (EP) or development and production plan (DPP). Lessees are advised that seasonal constraints may prevent the following from occurring in the same year: collecting required data, obtaining any necessary permits and coastal consistency certification, and initiating operations including mobilizing and setting down of the facility at location. Lessees are encouraged to plan accordingly (USDOI, MMS, 2006a).

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. These requirements are specified in the MMS Handbook 620.1H, Archaeological Resource Protection; in regulations (30 CFR 250.194; 30 CFR 250.211; 30 CFR 250.241; 30 CFR 250.1007(a)(5); and 30 CFR 250.1010(c)); and in law through the National Historic Preservation Act. The regulations at 30 CFR 250.214(e) and 30 CFR 250.244(e) require a shallow hazards report be included with all EPs or DPPs at the time they are submitted to MMS for completeness review. In addition, the Regional Director may require lessees to include an archaeological resources report as required by 30 CFR 250.227(b)(6) and 30 CFR 250.261(b)(6) with any EP or DPP submitted to MMS for completeness review. Lessees are encouraged to combine surveys whenever feasible (USDOI, MMS, 2006a). In the event that activities are planned in areas of known offshore historic resources or, based upon geophysical data, an area with a high potential for prehistoric resources, the MMS will require each lessee to prepare an archaeological report by a qualified archaeologist as specified in MMS NTL No. 05-A03, “Archaeological Survey and Evaluation for Exploration and Development Activities.” The MMS staff of trained geologists and geophysicists will interpret the geophysical data (which forms the basis of a subsurface archaeological report), and determine if activities are protective of cultural resources. Additionally, MMS’ G&G Permit Stipulation 6 (regarding the discovery of archaeological resources), CFR 251.6 (a) (5) regarding G&G Explorations of the Outer Continental Shelf to not “disturb archaeological resources,” and MMS’ NTL 05-A02, “Shallow Hazards Survey and Evaluation for Alaska Outer Continental Shelf (OCS) Pipeline Routes and Rights-Of-Way” would prevent or reduce any potential impacts to cultural resources.

Archaeological resource protection following an oil spill requires specific knowledge of the resource’s location, condition, nature, and extent prior to impact. However, large portions of the Alaska coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency response

(Wooley, Hillman, and O'Brien, 1997), these data have not been compiled for all areas of the Alaska. Subarea plans for the North Slope do reference procedures for addressing and mitigating potential impacts to archaeological resources should an oil spill occur (Alaska Regional Response Team, 2000).

Interagency and regulatory aspects of oil-spill archaeological site protection have also been clarified. A programmatic agreement (Regional Response Team, 1997) specifies the Federal On-Scene Coordinator's (FOSC's) role in protecting archaeological resources, the type of expertise needed for site protection, and the appropriate process for identifying and protecting archaeological sites during an emergency response. Under the agreement, the FOSC's Historic Properties Specialist coordinates and directs the site identification and protection program, with consultation and cooperation of the Unified Command and other affected and interested parties (USDOI, MMS, 2007c).

Additionally, in February 2002, an agreement ensuring the protection of Alaska archaeological resources when responding to oil or hazardous-material spills was signed by representatives of the U.S. Coast Guard, Environmental Protection Agency, U.S. Department of the Interior, U.S. Department of Agriculture, Alaska Department of Natural Resources, and the Alaska Inter-Tribal Council. The agreement establishes guidelines and procedures for gathering pertinent information about archaeological sites that may be at risk in an emergency response to a spill and institutionalizes a process for reconciling the requirements of the National Historic Preservation Act with the emergency response requirements of the Clean Water Act and the Oil Pollution Act of 1990 (www.akrrt.org/plans.html).

4.4.1.14.3. Anticipated Effects Under Alternative 1.

4.4.1.14.3.1. Anticipated Effects from Disturbance.

Prehistoric Resources. Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts between northeast Asia and the Americas (USDOI, MMS, 2007c).

The MMS currently requires that an archaeological survey be conducted prior to development of leases determined to have potential for prehistoric archaeological sites. Relative sea level data, which are used to define the portion of the continental shelf having potential for prehistoric sites, are sparse in the Alaska Region; however, the data that do exist suggest that the portion of the continental shelf shoreward of about the 60-m isobath would have potential for prehistoric sites. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to exploration activities. However, impacts to prehistoric resources may have resulted from routine activities prior to the implementation of the archaeological survey requirement, but the magnitude of possible impacts is impossible to quantify (USDOI, MMS, 2007c).

Historic Resources. Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The MMS currently requires that an archaeological survey be conducted prior to development of leases when an historic-period shipwreck is reported to lie within or adjacent to the lease area. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to

exploration activities. However, impacts to historic-period shipwrecks may have resulted from routine activities prior to the implementation of the archaeological survey requirement, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites that would have been impacted have been located, evaluated, and mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of possible impacts is impossible to quantify.

Cumulative Past and Present Actions. The greatest cumulative effect on archaeological resources in the Beaufort Sea and Chukchi Sea regions is from natural geologic processes such as ice gouging, bottom scour, and thermokarst erosion that have caused and will continue to cause a significant loss of historic data. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area. Ice gouges on the Beaufort Sea shelf can create a furrow up to 67-m wide and 4-m deep; the average ice gouge is about 8-m wide and 0.5-m deep (Barnes, 1984). If a shipwreck were to occur in an area of intense ice gouging, it would be destroyed. Coastal historic sites are exposed to the destructive effects of thermokarst erosion, causing artifacts to be dispersed and the site context to be disturbed or even completely destroyed. Overall, a significant loss of data from submerged and coastal historic sites probably has occurred and will continue to occur from the effects of natural geologic processes in the Alaska Region. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact (USDOJ, MMS, 2007c).

4.4.1.14.3.2. Anticipated Effects from Oil Spills, Oil-Spill Response, and Cleanup.

Anticipated effects on onshore archaeological resources from potential future oil spills is uncertain; however, data from the EVOS indicate that <3% of the resources within a spill area would be significantly affected (Dekin, 1993). The Dekin et al. (1993) study found that small amounts of petroleum hydrocarbons may occur in most archaeological sites within the study area. This suggests a low-level petroleum contamination that previously had not been suspected. Because the researchers found no evidence of extensive soil contamination from a single definable source (the oil spilled from the *Exxon Valdez*), they “now add [to other impact factors] the continuing contamination of soils from small and large petroleum spills in areas where present and past land use coincide” (Dekin et al., 1993). Vandalism was found to have a significant effect on archaeological site integrity but could not be tied directly to the oil spill (Dekin et al., 1993).

A potential spill would affect archaeological resources by creating surface-disturbing activities resulting from emergency shoreline and contaminated ground treatment. Following the EVOS, Exxon developed and funded a Cultural Resource Program to ensure that potential effects on archaeological sites were minimized during shoreline treatment (Betts et al., 1991). This program involved a team of archaeologists who performed reconnaissance surveys of the affected beach segments, reviewed proposed oil-spill treatment, and monitored treatment. As a result of the coastline surveys, hundreds of archaeological sites were discovered, recorded, and verified. This resulted in the most comprehensive archaeological record of Alaska coastline ever documented.

Although a number of sites in the EVOS area were vandalized during the 1989 cleanup season, the large number of Exxon and government agency archaeologists visible in the field may have lessened the amount of site vandalism that occurred (Mobley et al., 1990).

The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members also is a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed when mitigation is applied during cleanup activities. Various mitigation measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991; Wooley and Haggarty, 1993).

Cumulative Past and Present Actions. Although archaeological resources are not renewable, they are not affected directly or cumulatively by oil spills, the buildup of toxic substances, noise, or air pollution. Effects are minimized due to modern technologies and practices that reduce the impact to the environment and, therefore, to archaeological resources (no thawing of permafrost, restricted personnel access, wintertime operations, small-footprint drilling, and transportation technologies). Furthermore, mitigation measures, such as offshore high-resolution seismic surveys with archaeological analyses in zones of potential occurring resources, and onshore archaeological surveys where offshore pipelines make landfall, will avoid damage or destruction of potential archaeological resources.

Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed with the application of required during cleanup activities; therefore, the cumulative impact from oil spills to prehistoric archaeological sites would probably be moderate.

4.4.1.14.3.3. Anticipated Effects from Seismic Surveys. Ocean-bottom-cable seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water. Such offshore seismic-exploration activities could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS mitigation described in Section 4.4.1.14.2 above, any potential prehistoric and historic archaeological resources would be expected to be identified and avoided. Therefore, no impacts or only minor impacts to archaeological resources are anticipated.

Cumulative Past and Present Actions. Cumulatively, proposed seismic and OBC projects are not likely to disturb the seafloor. Cumulatively the impact to both prehistoric and historic archaeological sites should be negligible.

4.4.1.14.3.4. Anticipated Effects from Onshore Development. See the previous discussion of potential effects from onshore development in Section 4.4.1.14.1.4 above.

Cumulative Past and Present Actions. Onshore development has result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site has, in the past, likely caused physical damage to, or complete destruction of, information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have resulted from onshore construction activities prior to enactment

of the archaeological resource protection laws, and the magnitude of these possible impacts are impossible to quantify.

4.4.1.14.4. Direct and Indirect Effects Under Alternative 1. There would be no direct or indirect impacts on archeological resources in the project area from Lease Sales 209 or 217 if they were not conducted.

4.4.1.14.5. Cumulative Effects Under Alternative 1. Future MMS Sales 209 and 217 in the Beaufort Sea and ongoing projects in the region are summarized in Section 4.2.1 and include: (1) ongoing maintenance and development projects in local communities; (2) onshore oil and gas infrastructure development; (3) passenger, research, and industry-support aircraft activities; (4) local boat traffic, barge resupply to local communities, research vessel traffic, industry-support vessel activities (mostly in support of seismic surveys), an increasing U.S. Coast Guard presence, and vessel traffic from increasing Arctic ecotourism. Ongoing actions include: (1) development and production activities at Endicott, Northstar, Badami, and Alpine; (2) recent leasing from Beaufort Lease Sales 195 and 202; (3) State leasing; and (4) onshore leasing activity in the NPR-A. Other projects include BP's restart of the Liberty Development Project east of Endicott; Pioneer Natural Resources Co.'s development of its North Slope Oooguruk field in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit; and the Nikaitchug Development Project also in State waters off the Colville Delta. In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling off the Mackenzie River Delta in and GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area (USDOJ, MMS, 2006a).

In the Chukchi Sea, west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the DeLong Mountain Terminal. These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the Planning Area (USDOJ, MMS, 2006a).

Summary. The greatest cumulative effect on archaeological resources in the Beaufort and Chukchi Sea region is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area.

Accidental oil spills would affect onshore archaeological sites the most, but past cleanups have shown us that spilled oil had little direct effect on archaeological resources (Bittner, 1993). Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Various mitigation measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991; Wooley and Haggarty, 1993).

Although archaeological resources are not renewable, they are not affected directly or cumulatively by oil spills, the build up of toxic substances, noise, or air pollution. Effects are minimized due to modern technologies and practices that reduce the impact to the environment and therefore to archaeological resources (no thawing of permafrost, restricted personnel access, wintertime operations, small-footprint drilling and transportation technologies). Furthermore, mitigating measures, such as offshore high

resolution seismic surveys with archaeological analyses in zones of potential resources, and onshore archaeological surveys where offshore pipelines make landfall, would avoid damage or destruction of potential archaeological resources.

Cumulatively, proposed oil and gas projects in the region likely would disturb the seafloor, but remote-sensing surveys made before approval of any Federal or State lease actions should keep these effects low. Federal laws would preclude effects to most archaeological resources from these planned activities.

Conclusion. Generally, potential effects from activities increase with the level of activities, from the exploration phase to the development phase. Potential effects on archaeological resources would be from exploration and development activities on both onshore and offshore historic and prehistoric resources. Onshore resources are more at risk for effects from disturbance caused by construction or oil-spill-cleanup operations. Potential offshore resources are at greater risk from effects from bottom-disturbing activities, notably anchor dragging and pipeline trenching. In the exploration phase, some drilling could take place in deeper water, using floating drilling platforms or ships. These drilling units would use anchors and probably would have their blowout preventor buried, which could disturb potential archaeological resources in the immediate area. No impact is expected to prehistoric archaeological resources from activities in water depths >50 m. In the development phase, floating drilling and production platforms and possibly subsea production well-head assemblies would have the same disturbance effects on the seafloor as in the exploration phase: anchor dragging and digging the glory hole. The effect of gravel islands or bottom-founded production systems would be the compression and skirt penetration of sediments.

The OBC seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water. Such offshore seismic-exploration activities could disturb these resources and their in situ context. The application of MMS mitigation would be expected to identify and avoid any potential prehistoric and historic archaeological resources. Therefore, only negligible to minor impacts to archaeological resources are anticipated.

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. Cumulatively the potential impacts to both prehistoric and historic archaeological sites from regional oil and gas activities in the region should be largely eliminated due to archaeological surveys which are required prior to disturbance. Any archaeological resources, either onshore or offshore, will be identified before any activities are permitted, and they will be avoided or potential effects would be mitigated. Therefore, only negligible to minor impacts to archaeological resources are anticipated.

Some impact may occur to coastal historic and prehistoric archaeological resources from accidental oil spills. For these archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations, and primary oil-spill impacts to both prehistoric and historic archaeological sites would be expected to result from cleanup activities. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the EVOS, the impact most likely would be minor to moderate.

4.4.1.15. Environmental Justice.

Summary. There would be no direct or indirect Environmental Justice (EJ) effects in the project area from Lease Sales 209 or 217 if they were not held.

Potential major cumulative impacts to subsistence resources and harvests and sociocultural systems would indicate consequent major cumulative environmental justice impacts—disproportionate, high, adverse environmental and health effects on low-income, minority populations in the region. Alaskan Iñupiat Natives, a recognized minority, are the predominant residents of Beaufort and Chukchi seas coastal communities in the NSB and NWAB, the region potentially most affected by past, present, and reasonably foreseeable projects on- and offshore along the Chukchi and Beaufort coasts.

Environmental Justice effects on Iñupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices, sociocultural systems, and human health. Potential effects would focus on the Inupiat communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, Point Hope, and subsistence communities on the Russian Arctic Chukchi Sea coast. Offshore, major effects are not expected from routine activities and operations; however, if a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

Onshore, cumulative development, especially from potential road development within NPR-A and Alpine satellite field expansion, could impact subsistence resources and harvest practices. Subsistence resources, particularly caribou, could experience long-term disturbance and displacement effects, as well as functional loss of habitat and potential population reductions, causing subsistence hunters to alter traditional harvest practices by having to travel to unfamiliar areas. If this occurred, long-term displacement of ongoing social systems would be expected. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources would be altered, and disproportionate, high, adverse effects would be expected for the Inupiat communities of Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and possibly Point Hope.

Potential impacts on human health from contaminants in subsistence foods; changes in health status; and long-term climate change effects on marine and terrestrial ecosystems in the Arctic—affecting subsistence resources, traditional culture, and community infrastructure of subsistence-based indigenous communities in the NSB and NWAB—would be an expected and additive contribution to cumulative EJ impacts. Potential disproportionate, high, adverse effects on low-income, minority populations in the region are expected to be mitigated substantially but not eliminated.

Environmental Justice is an initiative that culminated with President Clinton's February 11, 1994, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, and an accompanying Presidential memorandum. The Executive Order (EO) requires each Federal Agency to make the consideration of EJ part of its mission. Its intent is to promote fair treatment of people of all races, so no person or group of people shoulders a disproportionate share of the negative environmental effects from this country's domestic and foreign programs. It focuses on minority and low-income people, but the EPA defines EJ as the "equal treatment of all individuals, groups or communities regardless of race, ethnicity, or economic status from environmental hazards" (U.S. Department of Energy, 1997; EPA, 2006). Specifically, the EO requires an evaluation as to whether the proposed project would have "disproportionately high adverse human health and environmental effects...on minority populations and low income populations." The EO also includes consideration of potential effects to Native subsistence activities, and this analysis explicitly includes effects on patterns of

subsistence resource use in its treatment of human health or environmental effects (CEQ, 1997). The protection of subsistence pursuits helps to guard against potential sociocultural disruptions that then fall under the purview of environmental justice. Mitigation measures should be developed to address all identified effects.

Disproportionate impacts under the guidelines for environmental justice evaluations are circumstances where direct and indirect project impacts could affect minority or low-income population groups to a greater extent than the general population. If such disproportionate impacts are found to occur, mitigation measures are identified that reduce, avoid, or eliminate these impacts (USDOJ, BLM, 2004). The evaluation of disproportionate impacts normally occurs in a circumstance where a number of diverse population groups could be affected by a proposed project that is in or near a major urban center. The evaluation seeks to determine if the minority or low-income groups among all of the affected groups are affected to a greater degree. In this case, potentially affected North Slope residents live in communities that are from 57-94% minority; thus, potential impacts caused by project activities are likely to affect residents in the Beaufort Sea and Chukchi Sea Planning Areas and also are likely to be disproportionate impacts under EJ. This does not mean all project impacts are disproportionate impacts. Only those that would directly or indirectly affect North Slope residents would be considered disproportionate impacts (USDOJ, BLM, 2004).

In addition, agencies must incorporate effective public participation and consultation in this process and provide full access to information. To this end, MMS maintains an active dialogue with local communities in the Beaufort and Chukchi sea regions. Since 1999, all MMS public meetings have been conducted under the auspices of EJ. Environmental Justice-related concerns are taken back to MMS management and incorporated into environmental study planning and design, environmental impact evaluation, and the development of mitigating measures (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2007d).

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, requires Federal Agencies to consult with tribal governments on Federal matters that significantly or uniquely affect their communities. In acknowledgement of the importance of consultation, MMS maintains an open policy that invites tribal governments to participate in its environmental assessment processes. In January 2001, a USDOJ Alaska Regional Government-to-Government policy was signed by all the USDOJ Alaska Regional Directors, including MMS. In 2006, MMS signed a Memorandum of Understanding (MOU) with the tribal government of Kaktovik that formalizes consultation and mutual cooperation between the community and MMS on MMS-specific projects that potentially could impact Kaktovik. Part of this formal cooperation has led to MMS funding the local hire of a Kaktovik environmental liaison position. In 2008, MMS and NSB signed an MOU that formalized NSB's role on providing for MMS's use in this EIS an assessment of human health impacts in the region (USDOJ, MMS, 2007d).

The Inupiat People of the NSB and NWAB have made MMS aware of the potential burden of participating in too many planning and public meetings. Therefore, MMS has taken measures to more carefully plan the number and timing of meetings with regional tribal groups and local governments.

Eighty-three percent of the population of the NSB, and 87% of the NWAB are minorities. Potential effects could be experienced by the Inupiat communities of both boroughs and evaluation of the demographic characteristics of Kaktovik, Nuiqsut, Barrow, Atkasuk, Wainwright, Point Lay, Point Hope, Barrow, and Nuiqsut in Section 3.4.3 found that the populations of each of these communities qualified as minority populations and require evaluation for disproportionate impacts. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and exploration and development may affect subsistence resources and harvest practices. The sociocultural and subsistence activities of these Native communities could be affected by seismic-noise effects, other disturbances, and oil spills. Many of these

effects contain an EJ component. The central issue of effects on subsistence will be used as a proxy or construct for this potential complex of EJ effects and will serve as the basis for a discussion of possible mitigation measures (USDOJ, BLM, 2004).

Public Health is one of the considerations in Environmental Justice. Whereas EJ focuses on the disproportionate public health (and other) impacts to potentially affected low-income and minority populations, the public health subsections in this EIS address the potential health effects to the NSB community as a whole, including non-EJ populations. The MMS and NSB established a Memorandum of Understanding for the NSB to provide information on public health for use in the Arctic Multiple-Sale EIS. The health effects analysis was undertaken by Aaron Wernham, MD, MS, and ANTHC Project Director, as consultant to the NSB. The information prepared and submitted by the NSB related to public health is presented in Appendix J. The appendix presents NSB's evaluation of public health impacts, along with mitigation measure suggested by NSB and Dr. Wernham. The appendix also includes a brief description of the method used for the human health description and analysis. A list of information sources and a list of limitations on the assessment are provided. The MMS intends to incorporate appropriate health impacts information into the Environmental Justice sections in the Final EIS. The proposed mitigation measures are still under consideration. The MMS and NSB have agreed to a series of work sessions to discuss these measures.

The public health component of EJ focuses on health outcomes and factors that determine these outcomes. The public health analysis provided by NSB considered impacts in the following Health Effects Categories (HECs): (1) General Health and Wellbeing; (2) Psychosocial/Gender issues; (3) Accidents and Injuries; (4) Contaminant Exposure; (5) Food, Nutrition, and Physical Activity; (6) Noncommunicable and Chronic Disease; (7) Cancer; (8) Infectious Diseases; (9) Maternal-Child Health; (10) Water and Sanitation; (11) Health Services Infrastructure and Capacity; and (12) Occupational/Community Health Intersection.

The unique focus of EJ results in a different analytical structure. Therefore, the EJ analysis that follows does not necessarily mirror the format used for other resource categories (USDOJ, MMS, 2003a).

Effects Definitions and Effects Levels. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, and this EIS define major effects on EJ as disproportionate high adverse impacts to low-income and minority populations.

Impacts identified in each resource area have been reviewed to determine if they also are “disproportionate impacts” to local residents. Both direct and indirect impacts were identified. Direct impacts have a direct impact on identified minority or low-income populations; impacts would be expected to directly affect the health, welfare, and cultural stability of the affected population. An example would be contamination of a resource, such as water, used directly by the affected population. Indirect impacts would be impacts on the viability or availability of resources essential for daily use of minority or low-income populations. An example might be environmental contamination that causes increased disease or contamination of fish or animals used in the daily diet. The contamination is an indirect impact. Impacts on resources that do not have this direct or indirect linkage would not be considered in the analysis (USDOJ, BLM, 2004).

4.4.1.15.1. Effects Assessment Overview. Coastal communities could experience impacts on subsistence resources and subsistence-hunting practices. These changes could occur as a result of noise and disturbance from seismic surveys; aircraft and vessel traffic; drilling activities; pipeline construction; structure placement; and support-base, pump-station, and gravel- and ice-road construction; and oil spills. Most Alaskan coastal communities are rural and predominantly Native (a defined ethnic minority), and

many contain at least subpopulations with low incomes. Therefore, specific local minority (and possibly poor [low-income]) populations are present that could be potentially affected by proposed activities.

The MMS is very sensitive to its responsibilities to evaluate the consequences of its activities in terms of EJ. By definition, OCS activities take place primarily offshore (with onshore support activities) and, thus, most directly affect coastal communities. Most Alaskan coastal communities are rural and predominantly Native (a defined ethnic minority), and many contain at least subpopulations with low incomes. That is, any OCS activity in Alaska is likely to significantly affect a specific local minority (and possibly poor [low-income]) population.

For these reasons, the MMS socioeconomic studies agenda has emphasized the documentation of subsistence uses, and the potential impacts of OCS activities on such uses, along with the more general characterization of rural (Native and non-Native) social organization and the incorporation of local and traditional knowledge. The MMS-sponsored studies have focused most heavily on communities on the North Slope (the area of most onshore and offshore oil and gas activity) and MMS has funded projects to synthesize local and traditional knowledge. The MMS has recognized the extreme importance of whales and whaling to the North Slope communities and has conducted a bowhead whale aerial survey annually since 1987. The MMS study *Qualitative Description of Potential Impacts of OCS Activities On Bowhead Whale Hunting Activities in the Beaufort Sea* completed in 2008 concluded that despite recent economic hardships, residents of the surveyed NSB communities and Savoonga believe that their quality of life has either stayed the same or improved. In Barrow, elders are more pessimistic about current quality of life trends, believing that a lack of jobs and increased substance abuse and crime are eroding traditional values. Still, most Barrow elders and elders from other communities do not believe their communities have become worse places to live. Whaling captains believe that oil and gas activities are the major disturbance producing factors on the fall bowhead whale migration but that climate change is producing the greatest disturbance on the spring migration. Overall, 59% of the whaling captains surveyed had less than definite opinions about development. On the negative side they felt development made subsistence activities more difficult to pursue and contributed to higher levels of alcoholism and drug abuse; on the positive side they saw development contributing to increases in job opportunities, higher household incomes, and higher tax revenues providing more social services. At the same time, 69% of the whaling captains did not believe that offshore oil development and a protected natural and cultural environment could co-exist. In Savoonga where no oil and gas development has occurred, only 28% of the whaling captains believed that development was incompatible with a sound natural and cultural environment (EDAW et al., 2008).

More than half of the whaling captains interviewed expressed confidence in their local community's ability to influence decisions concerning offshore oil and gas activities, due perhaps to a growing responsiveness to local concerns by industry although many others believed that this responsiveness often appeared to be "just going through the motions." A more disturbing finding of the study was the growing concern among elders that their influence in their communities was declining. Forty-six percent of Savoonga's elders and 33% of NSB community elders believed their influence had decreased, and in Barrow 29% reported a decline in sharing. Another study finding revealed that NSB communities, in comparison to Savoonga households, depended less on subsistence resources to meet their nutritional needs, but that recruitment of young people into subsistence pursuits was substantially the same for Savoonga and NSB communities (EDAW et al., 2008).

More importantly, perhaps, MMS has recognized the importance of local consultation, and the important role that the NSB, the NWAB, and other regional and local organizations and institutions can play in the development and evaluation of specific actions. Such a consultation process also will be a part of all actions addressed in this EIS. Although MMS has amassed an astounding body of public testimony—much of it from Alaskan Natives—as a result of the public hearing process, the Agency's consultation

process extends far beyond these formal hearings. The MMS now routinely includes Native representation on the Scientific Review Boards for its major projects, and tries to conduct at least occasional Information Transfer Meetings (discussing the findings of recently concluded and ongoing studies and proposed efforts) near those communities most likely to be affected. The most recent meeting, the Chukchi Sea Science Update Meeting, was held in Anchorage in October 2005. One overarching way MMS has tried to address Native concerns has been to include local Inupiat traditional knowledge in its environmental assessments (EAs) and EISs (USDOJ, MMS, 2007d). Major concerns expressed at public meetings include:

- Identifying and protecting important subsistence areas (all 6 communities);
- Restricting access to subsistence areas and resources (5 communities)
- Studying and maintaining the health of wildlife (3 communities);
- Providing natural gas to local communities (3 communities);
- Studying caribou and fish (3 communities);
- Mitigating seismic disturbance of caribou, fish, and whales (3 communities);
- Making better use of traditional knowledge (3 communities);
- Providing more local hire (3 communities);
- Updating outdated resource data (2 communities);
- Involving local people in scientific studies of resources (2 communities); and
- Including local people in the planning process (2 communities).

For the Arctic Multiple-Sale EIS planning process, MMS held public meetings in Point Hope, Point Lay, Nuiqsut, Barrow, Wainwright, and Anchorage in September-November 2007. Inupiat translation was provided where needed. Also in September-October 2007, Government-to-Government meetings with federally recognized tribes were held at the Native Village of Point Hope, the Native Village of Kaktovik; the Native Village of Nuiqsut; and the Inupiat Community of the Arctic Slope (ICAS).

During public meetings and Government-to-Government meetings, MMS personnel discussed proposed Lease Sales 209, 212, 217, and 221 and other OCS activities, including seismic-survey activity that had occurred during the summer 2007 season in the Beaufort and Chukchi seas, and the potential continuation of that activity in 2008. The presentations highlighted our desire to receive input on the resources, issues, alternatives, and mitigation measures to be included in the environmental analysis. We emphasized that the EIS is an information document that discloses the potential effects of the proposed actions and alternatives, including potential mitigation measures, and that no decision regarding the proposed actions had been made.

Information distributed at the meetings included a presentation on the NEPA process; a summary of past scoping comments associated with Beaufort Sea Lease Sales 186, 195, and 202 and Chukchi Sea Lease Sale 193; maps depicting the program areas for both the Beaufort and Chukchi seas; and an overview on participation in the scoping process. At these meetings, MMS received and documented input on issues, alternatives, mitigation measures, and EJ concerns.

All commenters from the communities were strongly opposed to the lease sales. The MMS also has participated in a recently initiated series of meetings with the NSB and the Alaska Inter-Tribal Council to discuss ways to incorporate a more systematic appraisal of human health concerns into the EIS process.

4.4.1.15.1.1. Factors Affecting Environmental Justice. The primary factors defined by Executive Order 12898 for assessing whether a Federal project would have disproportionate high adverse effects on minority and low income populations are: (1) the demographic factors of race and income, which establish minority and/or low income status of the potentially affected populations; (2) reliance on the consumption of fish and game (especially in Alaska, where there is a special provision of the EO to

consider Alaskan Native subsistence practices); and (3) human health effects. These factors are discussed below.

4.4.1.15.1.1.1. Demographics.

Race. For Alaska as a State, minority (“non-White”) populations constituted about 29% of the population in 2000. American Natives made up about 15.6% of the total population, African Americans about 3.5%, and Asian/Pacific Islanders about 4.5%. Most of the coastal regions in Alaska, except for Southcentral Alaska (Anchorage and the Kenai Peninsula), have significantly larger minority populations than the State as a whole. This is one component of the “urban-rural” divide between the Anchorage area and much of the rest of Alaska. The NSB is 83% “minority,” with 68% of the total population being Native American, 6.7% Asian/Pacific Islander, and 0.7% African American. Northwest Alaska is 87.7% “minority,” with 82.5% of the total population being Native American. For Southcentral Alaska, “minorities” constitute only about 20% of the population, and only about 8% of the total population is Native American, with the rest split between African Americans and Asian/Pacific Islanders. Because the communities in northwest Alaska and the NSB are predominantly Native communities, any effects discussed for these communities would be expected to be disproportionate (USDOJ, MMS, 2007c).

Alaskan Iñupiat Natives, a recognized minority, are the predominant residents of the NSB and NWAB, which make up the Alaska regional governments in the planning area. The 2000 Census counted 7,385 persons resident in the NSB; 5,050 identified themselves as American Indian and Alaskan Native for a 68.38% indigenous population. In the NWAB, the 2000 Census counted 7,288 persons, 5,944 identified themselves as American Indian and Alaskan Native for an 82.5% indigenous population (USDOC, Bureau of the Census, 2000). This defined majority status alone warrants an EJ of the Iñupiat population. Furthermore, Iñupiat Natives are the only minority population allowed to conduct subsistence hunts for marine mammals in the region and, in potentially affected Iñupiat communities, there are no significant numbers of “other minorities.” Additionally, “other minorities” would not be allowed to participate in subsistence marine mammal hunts and, therefore, would not constitute a potentially affected minority population (NSB, 1999).

Because of the NSB and NWAB’s homogeneous Iñupiat population, it is not possible to identify a “reference” or “control” group within the potentially affected geographic area (for purposes of analytical comparison) to determine if the Iñupiat are affected disproportionately. This is because a nonminority group does not exist in a geographically dispersed pattern along the potentially affected area of the NSB and the NWAB. Population counts from the 2000 Census for Native subsistence-based communities in the region, and their total American Indian and Alaskan Native population percentages can be seen in Table 3.4.5-1 (USDOJ, MMS, 2007d).

Income. The U.S. average median household income in 2000 was \$42,148, and the U.S. average per-capita income was \$29,469. The Alaskan average median household income in 2000 was \$50,746, and the Alaska average per-capita income was \$29,642. About 9.4% of Alaska’s 2000 population was below the poverty line, and mean income was \$57,171 (median income was \$51,571). The average NSB median household income (\$63,173) was above State and national averages, but the average per-capita income (\$20,540) was below the State and national averages. The median household incomes in all subsistence-based communities in the NSB were above State averages, except Nuiqsut (\$48,036), and all were above national averages. Per-capita incomes in all these communities were below State and national averages. The thresholds for low income in the region were household incomes below \$57,500 in the NSB. The average NWAB median household income (\$45,976) was below the State average but above the national average, but the average per-capita income (\$15,286) was below State and national averages. The median household incomes of the subsistence-based communities of Kivalina (\$30,833), Buckland (\$38,333), and

Deering (\$33,333) were below State and national averages, and those for Kotzebue (\$57,163) and Noorvik (\$51,964) were above. Per capita incomes in all these communities were below State and national averages.

Low income commonly correlates with Native subsistence-based communities in coastal Alaska; however, subsistence-based communities in the region qualify for EJ analysis based on their racial/ethnic minority definitions alone; nevertheless, the figures indicate that low income commonly also correlates with Native subsistence-based communities in the region (USDOC, Bureau of the Census, 2000, 2002). The poverty-level threshold for a family of four, based on the U.S. Census Bureau, 2000 Survey data, is \$17,761. Low income is defined by the U.S. Census Bureau as 125% of the poverty level or \$22,201. Median household incomes for the NSB and the NWAB fall well above the Census Bureau threshold for low income. The 2000 Census “tiger” files (files from the U.S. Census’ Topologically Integrated Geographic Encoding and Referencing [TIGER] database) identify no nonsubsistence-based coastal communities in the NSB and the NWAB with median household incomes that fall below the low income threshold.

The median household, median family, and per capita incomes; the number of people in poverty; and the percent of the total Borough or Native subsistence-based community population are shown in Table 3.4.5-1 (USDOJ, MMS, 2007d).

4.4.1.15.1.1.2. Consumption of Fish and Game. As defined by the NSB Municipal Code, subsistence is “an activity performed in support of the basic beliefs and nutritional need of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities” (ADNR, 1997). This definition gives only a glimpse of the importance of the practice of the subsistence way of life in Inupiat culture, but it does underscore that it is a primary cultural and nutritional activity on which Native residents of the North Slope and Northwest Arctic depend. For a more complete discussion of subsistence and its cultural and nutritional importance, see Section 3.4.2 Subsistence Harvest-Patterns.

Potential effects focus on the Inupiat communities of the Chukchi/Beaufort region. The sociocultural and subsistence activities of these Native communities could be affected by accidental oil spills. Possible oil-spill contamination of subsistence foods is a concern regarding potential effects on Native health. Interestingly, after the EVOS, testing of subsistence foods for hydrocarbon contamination from 1989-1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods. In fact, the U.S. Food and Drug Administration (FDA) concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al., 1999). They recommended avoiding shellfish, which accumulates hydrocarbons.

Whether subsistence users will use potentially tainted foods is entirely another question that involves cultural “confidence” in the purity of these foods. Based on surveys and findings in studies of the EVOS, Natives in affected communities largely avoided subsistence foods as long as the oil remained in the environment. Perceptions of food tainting and avoiding use remained (and remain today) in Native communities after the EVOS, even when agency testing maintained that consumption posed no risk to human health (ADF&G, 1995; Hom et al., 1999; Burwell, 1999).

The ability to assess and communicate the safety of subsistence resources following an oil spill is a continuing challenge to health and natural resource managers. After the EVOS, analytical testing and rigorous reporting procedures to get results out to local subsistence users were never completely convincing to most subsistence users about the safety of their food, because scientific conclusions often were not consistent with Native perceptions about environmental health. According to Peacock and Field (1999), a discussion of subsistence-food issues must be cross-disciplinary, reflecting a spectrum of

disciplines from toxicology, to marine biology, to cultural anthropology, to cross-cultural communication, to ultimately understanding disparate cultural definitions of risk perception itself. Any effective discussion of subsistence-resource contamination must understand the conflicting scientific paradigms of Western science and traditional knowledge in addition to the vocabulary of the social sciences in reference to observations throughout the collection, evaluation, and reporting process. True restoration of environmental damage, according to Picou and Gill (1996): “must include the reestablishment of a social equilibrium between the biophysical environment and the human community” (Field et al., 1999; Nighswander and Peacock, 1999; Fall et al., 1999). Since 1995, subsistence restoration resulting from the EVOS has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall et al., 1999; Fall and Utermohle, 1999; USDOJ, MMS, 2007d).

4.4.1.15.1.2. Factors Affecting Public Health. An analysis of public health must account for the social, economic, and environmental influences on health status. In addition to the discussion below and health discussion under each impacting factor, these factors are also addressed in NSB’s public health evaluation presented in Appendix J.

4.4.1.15.1.2.1. Impacts to Subsistence. As discussed in section 3.4.2, subsistence is the cornerstone of nutrition, culture, and social systems in NSB communities. A vital, productive subsistence way of life is strongly correlated with measures of overall well-being and psychosocial health in Arctic communities (Poppel et al., 2007; Hicks and Bjerregaard, 2006; Shepard and Rode, 1996). Impacts to the subsistence harvest, if severe enough, would also impact food security, nutritional status, and the risk of nutritionally-based chronic medical problems such as high blood pressure, obesity, diabetes, and cardiovascular disease. Anyone dependent on subsistence resources could experience these effects to some degree, but they would be most prominent in Inupiat residents of the region where current data suggest that subsistence is a cornerstone of general wellbeing as well as physical health.

4.4.1.15.1.2.2. Changes in Environmental Quality. The North Slope environment and local communities have several unique aspects that must be considered when evaluating the influence of environmental quality on health. The NSB communities maintain strong ties with and dependence on the natural environment and subsistence resources; residents spend considerable time on the land in subsistence activities, and consume large quantities of locally-harvested fish and game. Fish, game, marine mammals, and other subsistence foods can bioaccumulate some organic pollutants; hence, exposure to locally-produced contaminants is a matter of ongoing concern in local communities. The North Slope environment is also unique in that global transport of contaminants concentrates some pollutants such as persistent organic pollutants (POPs) and mercury from worldwide sources. Finally, Alaska Natives in the NSB region have high rates of cancer and lung disease, both of which may be associated with exposure to environmental pollutants. Each specific subtype of cancer has a variety of genetic, behavioral, and environmental risk factors. Often, a given pollutant may be a risk factor for only specific subtypes of cancer, which complicates the assessment of potential links between environmental pollution and cancer. Furthermore, other risk factors, such as high smoking rates, have been identified as risk factors for certain subsets of cancer. Because of both the issue of increased dietary exposure and the large amounts of wild-harvested resources and the issue of Arctic accumulation of contaminants, contaminants pose a strong and ongoing concern for NSB residents.

The main potential exposure pathways to contaminants for residents of the region would include:

- (1) Consumption of tainted subsistence resources. Pollutants could contaminate local subsistence resources and expose individuals to contaminants when the harvested resource is consumed.

- (2) Inhalation. Emissions from combustion could be entrained in the local airshed, and inhaled by residents; subsistence hunters travelling near combustion sites, and residents nearest major emissions sources would be at greatest risk.
- (3) Direct contact. Exposure to pollutants could occur through direct contact with skin.
- (4) Contaminated drinking water: Drinking water in the NSB is generally taken from surface water bodies (streams and lakes), which could become contaminated by airborne pollutants or direct contact with contaminate spills.

4.4.1.15.1.2.3. Changes in Sociocultural Conditions, Demographics, and Economy. As discussed in section 3.4.5, the field of public health has long recognized that “socio-economic status,” as measured by factors such as income, employment status, and level of education, play a powerful role in health and disease. These factors, sometimes referred to as the “social determinants of health,” account for at least 40% of disease rates in the U.S. (Adler and Newman, 2002; Lantz et al., 2003; Pamuk et al., 1998). Studies in the Arctic have identified effects of socioeconomic change on social and psychological health problems (stress, alcohol and substance abuse, family violence, and suicide) (Shepard and Rode, 1996; Hicks and Bjerregaard, 2006; Bjerregaard and Young, 2004). Studies have identified physical health outcomes attributable to social and economic conditions in the Arctic (Lantz et al., 2006; O’Neil et al., 2003; Shaw et al., 2006; WHO, 2007; Pamuk et al., 1998).

Influx of nonresident workers from outside the region can introduce new value systems and generate cultural tensions. This effect would be most prominent for Inupiat members of NSB communities. New access routes, such as ice roads and permanent roads, can change the level of isolation in a community, increasing commerce and travel between urban centers and villages. Residents have reported that the ice road constructed to Nuiqsut each year has facilitated illicit drug and alcohol trafficking into a village which has banned the sale and possession of alcohol; in turn, access to alcohol and drugs increases the risk of injuries, violence, and social conflict (USDOJ, BLM, 2004).

Non-resident workers can also be a source of infectious disease transmission. Transmission of sexually transmitted diseases and bloodborne infections between high and low prevalence groups is a commonly recognized and significant concern with resource development projects in indigenous and remote rural communities (IFC, 2007; Utzinger et al., 2005).

4.4.1.15.2. Potential (Unmitigated) Effects to Environmental Justice. As described in Section 3.4.2, subsistence defines the core cultural values and plays a central role in the social organization, family relationships, and economy of NSB Alaska Native communities. In the North Slope region, several studies have addressed questions of the effect of living conditions on well-being. The recently completed Survey of Living Conditions in the Arctic (SLiCA) found that higher levels of income were not linearly associated with measures of well-being. In this sample, independent of income, 44% of surveyed participants who were categorized as “most active” in subsistence said they were “very satisfied” with their lives, compared with only 30% of those in the “least active” group (Poppel et al., 2007). According to available data (see Section 3.4.5), wild-harvested foods also make up a considerable portion of the diet and nutrition in North Slope Alaska Native communities. Consequently, subsistence effects carry important implications for general health and well-being. The subsistence diet and way of life are the main protection for North Slope communities against chronic diseases such as cardiovascular disease and diabetes (Murphy et al., 1997; Young et al., 1992; Bjerregaard/Young et al., 2004; Bjerregaard/Jorgensen et al., 2004). The sharing networks, cooperation, and close relationships between families and communities are a measurable form of social capital and social support. Social support is a powerful predictor of life expectancy and both psychological and physical health and well-being (Marmot and Wilkinson, 2003; Ritchie and Gill, 2004).

4.4.1.15.2.1. Potential Effects from Disturbance. Potential effects from disturbance on subsistence resources and practices were discussed in Sections 4.4.1.12.1.1 and 1.2 and 4.5.1.12.1.1 and 1.2 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from disturbance on sociocultural systems were previously discussed in Sections 4.4.1.13.1.1 and 4.5.1.13.1.1 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population.

Onshore, in the vicinity of Nuiqsut, increases in the amount of area made available for leasing and exploration would have a corresponding increase in the effects to subsistence harvests. Any development proposed would require increased staging and overland travel during winter, and in summer would require increased use of aircraft for supplies, equipment, and crew changes. In turn, this would result in a relative increase in presence of oil-industry personnel in the villages and subsistence areas. In all seasons, noise, lights, personnel, and traffic near oil and gas-related infrastructure temporarily could deflect or divert caribou in areas where activities are occurring; however, gravel pads could attract caribou during some seasons as insect-relief habitat. These effects could change the distribution, timing, and location of the caribou harvest, which could require increased effort and expenditure, travel time, and risk on the part of subsistence hunters, resulting in sociocultural consequences such as increased stress and a decreased sense of well-being. Development in and near rivers that serve as important sources of fish harvest also could lead to decreases in the total fish harvest for impacted villages. Such subsistence and sociocultural impacts also would represent EJ impacts (USDOI, BLM, 2005).

4.4.1.15.2.2. Potential Effects from Discharges. Potential effects from discharges on subsistence resources and practices were discussed in Sections 4.4.1.12.1.3 and 4.5.1.12.1.3 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

4.4.1.15.2.3. Potential Effects from Oil Spills. Potential effects from oil spills on subsistence resources and practices were discussed in Sections 4.4.1.12.1.4 and 4.5.1.12.1.4 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from oil spills on sociocultural systems were discussed in Sections 4.4.1.13.1.2 and 4.5.1.13.1.2 for the Beaufort and Chukchi seas no-action alternatives. A detailed oil-spill-risk analysis for subsistence resources and practices appears in Sections 4.4.2.12.1.4 and 4.5.2.12.1.4 for the Beaufort and Chukchi seas Proposed Action Alternatives (Alternative 2). These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Combined probabilities express the percent chance of one or more oil spills $\geq 1,000$ bbl occurring and contacting a certain environmental resource areas and land segments over the production life of the Beaufort Sea Sales 209 and 217. For combined probabilities, the oil-spill model estimates a $<0.5\%$ chance that an oil spill would occur from a platform or a pipeline and contact subsistence-specific ERAs 38 (Point Hope), 39 (Point Lay), 40 (Wainwright), 41 (Barrow Subsistence Whaling Area 1), 60 (King and Shingle Point—Canada), 90 (Gary and Kendall Islands—Canada), and 97 (Tigvariak Island) for both 30 and 360 days. The oil-spill model estimates a 1% chance that an oil spill would occur and contact subsistence-specific ERAs 42 (Barrow Subsistence Whaling Area 2), 43 (Nuiqsut Subsistence Whaling Area), and 44 (Kaktovik Subsistence Whaling Area) for 30 days and a 1-2% chance for 360 days.

The potential for bowhead whales to be contacted directly from an oil spill from the Beaufort Sea sales is relatively small, but the potential chance of contact to whale habitat, whale-migration corridors, and

subsistence-whaling areas is considerably greater. Onshore areas and terrestrial subsistence resources, in general, seem to have a lower potential for oil-spill contact.

Combined probabilities express the percent chance of one or more oil spills $\geq 1,000$ bbl occurring and contacting certain environmental resource areas and land segments over the production life of Chukchi Sea Sales 212 and 221. For combined probabilities, the oil-spill model estimates a $<0.5\%$ chance that an oil spill would occur from a platform or a pipeline and contact subsistence-specific ERAs 3 (Russian Coastal Communities Subsistence), 4 (Russian Coastal Communities Subsistence), 5 (Shishmaref), 13 (Kivalina), 41 (Barrow Subsistence Whaling Area 1), 43 (Nuiqsut), 97 (Tigvariak Island), and 44 (Kaktovik) for both 30 and 360 days. The oil-spill model estimate of the chance that an oil spill would occur and contact subsistence-specific ERAs 38 (Point Hope) is 1%, 39 (Point Lay) is 5%, 40 (Wainwright) is 5%, and 42 (Barrow Subsistence Whaling Area 2) is $<0.5\%$ for 30 days. For 360 days, the chance that an oil spill would occur and contact subsistence-specific ERAs 38 (Point Hope) is 1%, 39 (Point Lay) is 7%, 40 (Wainwright) is 8%, and 42 (Barrow Subsistence Whaling Area 2) is 1%.

Over the production life of Alternative 2, the OSRA model estimates a $<0.5\text{-}1\%$ chance of one or more large oil spills occurring and contacting Point Lay subsistence LSs 71-75 within 30 days and a 1% chance of one or more large oil spills occurring and contacting these LSs within 360 days. The OSRA model estimates a $<0.5\%$ chance of one or more large oil spills occurring and contacting Wainwright subsistence LSs 78-80 within 30 days, and a 1% chance of one or more large oil spills occurring and contacting these LSs within 360 days.

The potential for bowhead whales and other marine mammals to be contacted directly from an oil spill is relatively small, except in areas off Point Lay and Wainwright, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas in the Chukchi Sea (both Russian and American waters) is considerably greater. Onshore areas and terrestrial subsistence resources, in general, would have a lower potential for oil-spill contact.

The only substantial source of potential EJ-related effects to coastal subsistence-oriented communities on the Alaskan and Russian Chukchi Sea coastline would occur in the event of a large oil spill, which could affect subsistence resources. A large oil spill could contaminate essential whaling areas and marine mammal harvest areas, and major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

Onshore spill would likely occur within containment structures and so are unlikely to have long-term, extensive impacts that would affect water quality, habitat, or subsistence species. Spill impacts, to the extent that they occur, would be episodic, not continuous. Local residents have shown a propensity to avoid resources from areas where spills have occurred because of a lack of confidence that subsistence resources have not been contaminated. This lack of confidence could affect subsistence use for a period beyond the time when any resources affected from spills would actually persist (USDOI, BLM, 2004, 2005).

Large oil spills could cause effects on public health through contact with contaminants, which could occur mainly through inhalation, skin contact, or intake of contaminated subsistence foods; through reduced availability or acceptability of subsistence resources; periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup, and stress due to fears of the long-term implications of a spill and the disruptions it would cause. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales and other marine mammals from an oil spill, and overall effects from these sources could be expected to displace ongoing sociocultural systems (USDOI, MMS, 2007d).

4.4.1.15.2.4. Potential Effects from Oil-Spill Response and Cleanup. Potential effects from oil-spill response and cleanup on subsistence resources and practices were discussed in Sections 4.4.1.12.1.4.2.2 and 4.5.1.12.1.4 for the Beaufort and Chukchi seas no-action alternatives; potential effects from oil spill response and cleanup on sociocultural systems were discussed in Sections 4.4.1.13.1.3 and 4.5.1.13.1.3 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population. See also Section 4.4.1.15.2.3 above.

Cleanup efforts for a large oil spill could involve 60 to 190 cleanup workers. Increased employment of local residents as spill cleanup workers could have positive economic benefits from increased wage income, as well as the negative effects occurring from inflation and displacement of Native residents from their normal subsistence-harvest activities. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs. On the other hand, employment and income are generally associated with positive health outcomes. An increased influx of non-resident personnel through communities would be highly likely, and could have impacts on social interactions and commerce-related factors such as the local economy and inflation.

4.4.1.15.2.5. Potential Effects of Airborne Emissions. Airborne emissions include the EPA “criteria pollutants” (NO_x, SO₂, PM₁₀, PM_{2.5}, lead, and CO, and, indirectly, ozone, through photochemical reactions with NO_x), which have been associated with an array of health effects, the most common and significant of which include: causing and exacerbating respiratory illnesses such as asthma; increased risk of cardiac arrhythmias; exacerbated atherosclerotic coronary artery disease; and excess overall mortality rates among vulnerable groups. According to the EPA, PM_{2.5} in particular is associated with “increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease” (EPA, 2005). The possible effects of emissions must be viewed in the broader context of air quality on the North Slope. Potentially important sources of exposure to air pollutants include oil and gas activities, road dust, combustion of fuels (for example, auto exhaust, powerplant emissions), indoor air pollution, and burning of refuse (USDOJ, BLM, 2007).

Hazardous Air Pollutants (HAPs) emitted by oil activities can have adverse impacts on public health. The HAPs most commonly associated with oil and gas activities include: benzene, toluene, ethylbenzene, and xylene (BTEX), and PAHs (a large category of chemically related pollutants produced by combustion of hydrocarbons.) Some of these compounds are known or suspected human carcinogens.

4.4.1.15.2.6. Potential Effects from Seismic Surveys. Potential effects from seismic surveys on subsistence resources and practices were discussed in Sections 4.4.1.12.1.5 and 4.5.1.12.1.5 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from seismic surveys on sociocultural systems were previously discussed in Sections 4.4.1.13.1.4 and 4.5.1.13.1.4 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Any disruption of subsistence harvests by seismic activity could disrupt the central Inupiat cultural value (subsistence), the foundation of the North Slope nutritional system, and sharing networks, and would thereby adversely affect indicators of general health and wellbeing and could adversely impact the rates of psychosocial problems, such as family violence, drug and alcohol problems, depression, anxiety, and

suicide. Perceived and actual threats to subsistence constitute a significant source of ongoing stress and tension in North Slope communities.

Displacement of whales would increase the distances that whalers must travel for successful harvests and potentially involve travel into rougher waters, with a proportional increase in the risk of accidents and injuries. The longer distances and time required would increase exposure of whaling crews to weather changes, which would compound the risk. Indirect impacts from stress over harvest failures related to seismic activity could lead to maladaptive coping such as alcohol abuse. Food insecurity would thus likely increase as a result of bowhead whale harvest failures or extended harvest failures of other species.

4.4.1.15.2.7. Potential Effects from Habitat Loss. Potential effects from habitat loss on subsistence resources and practices are discussed in Sections 4.4.1.12.1.6 and 4.5.1.12.1.6 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from habitat loss on sociocultural systems are discussed in Sections 4.4.1.13.1.5 and 4.5.1.13.1.5 for the Beaufort and Chukchi seas no-action alternatives. Habitat loss would be expected to impact EJ to the extent it adversely impacted subsistence resources and practices and sociocultural systems. All these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

4.4.1.15.2.8. Potential Effects from Onshore Development. Potential effects from offshore and onshore development on subsistence resources and practices are discussed in Sections 4.4.1.12.1.7 and 4.5.1.12.1.7 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from offshore and onshore development on sociocultural systems are discussed in Section 4.4.1.13.1.6 and 4.5.1.13.1.6 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Impacts on subsistence harvests and uses would arise from impacts on the availability of subsistence species in traditional-use areas or a decrease in subsistence-hunting success. The reduction in subsistence-hunting success, in turn, reduces the availability of Native foods to the Nuiqsut community. Because the Native community is the only community that depends to a significant degree on subsistence foods, this impact, to the extent that it occurs, falls disproportionately on the local Native population. Displacement of subsistence hunters from traditional subsistence-use areas by oil-industry facilities also means greater time spent traveling longer distances to other subsistence-use areas.

4.4.1.15.2.9. Potential Effects of Economic, Employment, and Demographic Change.

As described in Section 3.4.5, Socioeconomic status, as measured by income, education, or employment variables, is associated with both population health indicators—such as life expectancy and overall mortality rates—and rates of individual diseases such as cancer and cardiovascular disease (Adler and Newman, 2002; Pamuk et al., 1998). Some studies of Arctic indigenous communities, including the NSB population, suggest that the relationship is more complex. Factors related to socioeconomic change, such as cultural disintegration, loss of indigenous language, and the growing contribution of modern convenience foods to the diet in rural villages, for example, have contributed to health problems (WHO, 2007; Curtis et al., 2005; Poppel et al., 2007). On the other hand, income from employment and other oil revenues supports fuel and equipment for subsistence activities and, thus, supports general health and well-being. Economic decline, job loss, and poverty are strongly associated with increased all-cause mortality and the development of a number of specific health problems (Jones, 1991).

Economic depression and unemployment are risk factors for social and psychological problems (Murali and Ovebode, 2004; Adelson, 2005). The rapid influx of nonresident personnel to or through a community could lead to increased social and psychological problems.

Subsistence constitutes a mainstay of the nutritional system of NSB communities and the primary protection against food insecurity, nutritional deficiencies, and metabolic disorders such as diabetes, obesity, high blood pressure, and cardiovascular disease. Income from oil activities supports subsistence activities. On the other hand, the transition from subsistence to a cash economy has been associated in an increased reliance on market foods. Furthermore, there are data that employment in industrial settings for Arctic subsistence peoples may interfere with subsistence hunting.

Compelling data have also linked social and economic factors to respiratory health outcomes. For example, in Alaska a recent study demonstrated that the average educational status in a community was a strong predictor of asthma outcomes (Gessner, 2008). Similarly, data have shown that poverty predicts adverse health outcomes from exposure to pollution (O’Neil et al., 2008). Chronic lung disease is highly prevalent in the NSB, and oil activities where substantial contact between residents and nonresident workers is anticipated could create conditions where minor respiratory infections are transmitted between workers and the community, with more serious consequences for community members with baseline pulmonary problems.

4.4.1.15.2.10. Potential Effects from Production Activity. Potential effects from production activity on subsistence resources and practices were discussed in Sections 4.4.1.12.1.8 and 4.5.1.12.1.8 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from production activity on sociocultural systems were discussed in Sections 4.4.1.13.1.7 and 4.5.1.13.1.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Onshore, activities associated with dismantling and removing the Alpine satellite structures could disproportionately affect Nuiqsut residents through disturbance, displacement, and mortality of subsistence resources; through subsistence users’ avoidance of areas undergoing dismantlement and removal; through potential impacts on water and air quality; and through noise. Once abandonment and rehabilitation are completed, Nuiqsut residents may be disproportionately affected by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Local residents could benefit from a reduction in impacts on subsistence resources compared to impacts during construction and operation (USDOJ, BLM, 2004, 2005). New roads and access routes could be associated with social impacts for previously isolated villages.

There may be both direct, highly localized effects in addition to effects that are more generalized over the entire region. For example, localized tensions may result when a project causes a large influx of transient workers into a single village, generating interracial conflict; feelings of disempowerment among residents wishing to protect their traditional way of life; ambivalence among youth who must rectify their attachment with Inupiat traditional culture and outside, non-Native value systems, modes of communication, diet, and lifestyle; and domestic tensions as family providers feel pressure to be both successful hunters and economic providers. On the other hand, more generalized regionwide acculturative forces include increases in the economic standard of living, employment, and educational opportunity, and economic disparity.

Production activities could exacerbate accident and injury rates if people resort to maladaptive coping strategies such as alcohol or substance abuse, or if hunters find it necessary to travel longer distances to find subsistence resources. Stress produced by the loss of traditionally important subsistence-hunting areas, and the fear of curtailed ability to continue pursuing a subsistence way of life, food insecurity, and the longer travel distances and more difficult hunting conditions produced by displacement of subsistence resources and hunters by oil infrastructure all would contribute to increases in social pathology (USDOJ, BLM, 2005).

For many years, North Slope residents have expressed concerns regarding possible contamination of the environment, and in particular of subsistence foods, by local industrial development, and the potential effects to human health. Environmental contaminants may enter the human environment through airborne emissions (as discussed above); through liquid and solid-phase discharges such as drilling muds, and spills; and biomagnification through the food chain.

The influx of non-resident workers to NSB communities during production activities, coupled with the potential development of new access routes to previously isolated communities, creates the possibility of transmission of pathogens between the NSB residents and people entering the region from outside the region. An influx of nonresident workers to the region could add incrementally to the burden on local health services, and could be a concern if a support base were constructed near a village.

After the termination of development, revenues to the NSB and local Native corporations likely would decline considerably. Rehabilitation work available might lead to a transient increase in employment, but this likely would be followed by a period of significant economic contraction because of both decreasing NSB revenues and loss of direct jobs. Economic depression and job loss are strongly associated with social pathology, which likely would increase during this period. It is possible that subsistence resources could become more readily accessible after a period of adjustment, but this must be viewed as purely speculative. If this occurred, it would help offset effects of decreasing capital available for the purchase and repair of hunting equipment and fuel purchase. The decline of these revenues is likely to have profound effects. It is not at all clear whether people would be able to resume their predevelopment way of life, whether subsistence resources would be depleted, contaminated, or displaced, or how people would continue to support a lifestyle that depends heavily on modern technology. Viewed from the perspective of the social determinants of health, this period could have substantial implications for health given the large-scale economic and employment transition anticipated. Another concern would come from the potential leakage of contaminants from wells and dumpsites: residents have expressed concern that if the area is less stringently monitored after development ceases, contamination of rivers, lakes, and estuarine habitats could occur and would be missed with monitoring, with substantial implications for human health (USDOJ, BLM, 2005).

The MMS believes there would be some clear benefits derived from production projects: an ad valorem tax would accrue to the NSB from new onshore infrastructure (landfall infrastructure and pipelines) associated with such development. Oil from these projects would help keep flow capacity up in the TAPS, a situation that helps the NSB tax base, and additional ad valorem tax would accrue to the NSB because of increased flow of oil through existing pipeline infrastructure taxed by the Borough. Industry local-hire initiatives are increasing in terms of the variety of programs being offered to train and attract Inupiat workers for long-term employment on the North Slope. The MMS cannot require local hire, but MMS and other Federal Agencies can inform the operator of the Native concerns for more local employment from nearby oil and gas developments (USDOJ, MMS, 2003a).

There may be some degree of development-induced local employment, but these changes, particularly as they translate into Native employment, historically, have been and are expected to continue to be insignificant. Even though Native employment in oil-related jobs on the North Slope is low, Native leaders continue to push for programs and processes with industry that encourage more Native hire. The NSB has attempted to facilitate Native employment in the oil industry at Prudhoe Bay and is concerned that the industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural needs in participating in subsistence hunting. The NSB also is concerned that industry recruits workers using methods more common to Western industry practices and would like to see the oil industry make a more concerted effort, and one that is more appropriate to the Inupiat, to hire NSB residents. Few village residents are employed by the oil industry, even though recruitment efforts are made and training programs are available. One slope operator, BPXA, has instituted its *Itqanaiyagvik*

hiring and training program, designed to put more Inupiat into the oil-field workforce. It is a joint venture with the ASRC and its oil-field subsidiaries and is coordinated with the NSB and the NSB School District. Other initiatives are an adult “job-shadowing” program, and an effort called Alliances of Learning and Vision for Under Represented Americans, developed with the University of Alaska to prepare candidates for degree programs in technical and engineering professions. Most graduates of the adult job-shadowing program already are working in oil-field jobs (BPXA, 1998c). Iligsavik College in Barrow was specifically established to train young Natives for work in the oil fields (USDOJ, MMS, 2007d).

Additional potential employment benefits include indirect and induced employment that would occur in the government sector, which are funded through taxation of oil facilities. While there may not be increases in employment, because the current onshore projects are decreasing in production and taxation value, the increases created by OCS development would help to offset these decreases during the lives of OCS projects (USDOJ, MMS, 2003a).

The cash economy of the potentially affected communities includes the wage income of community members, income derived by businesses owned by community members, and royalty and tax revenues and other distributions that flow to each community. Increases in personal or family income resulting from increased Native corporation dividend distributions could occur. Economic impacts on local communities should be positive but may not benefit local communities, if the jobs and revenue generated in the communities do not offset the effects of loss of subsistence harvests and land use. Circumpolar Research Associates reported that long-time Nuiqsut residents did not get jobs in the local oil fields; rather, most people were hired from other communities and moved to Nuiqsut after getting the jobs (Circumpolar Research Assocs., 2002; USDOJ, BLM, 2004; USDOJ, BLM and MMS, 2003).

Only a minimum increase in local business income would be expected. However, many of the contractors hired by the oil industry to support exploration, drilling, and production on the North Slope are Native corporations (ASRC and others), subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures and other relationships. In Nuiqsut, more than \$250 million dollars in contract fees were received by the Nuiqsut Village Corporation, Kuukpik Corporation, during development of the Alpine Field’s satellite facilities CD-1 and CD-2. To the extent that these companies are successful bidders for contracts during construction and operation, significant local economic benefits are expected to result (USDOJ, BLM, 2004).

The NSB communities were concerned by a recent legislative initiative to reallocate revenues from Federal lease sales in the NPR-A. The proposal in the State legislature tightened the rules for awarding these monies to locally impacted communities and taking a bigger cut for the Permanent Fund (Sutton, 2006). Protests from local communities, the NSB, and regional legislators eventually defeated the effort, but the action does point out the difference in views among some legislators and local communities for development-oriented impacts to communities in the region. Locally, the NSB continues to adopt rezoning ordinances to accommodate nearshore development projects, including the Nikaitchuq and Oooguruk projects, both seaward of the Colville River Delta (Cashman, 2006a). As part of the rezoning measure, the operator was tasked with entering into a conflict avoidance agreement with the AEWG and formulating a Good Neighbor Policy, as well as coordinating barging and vessel traffic with whaling activities. The operator, as well, established a Nuiqsut Mitigation Fund with Nuiqsut’s Kuukpik Corporation, the City of Nuiqsut, and the Native Village of Nuiqsut (Cashman, 2006). ConocoPhillips also recently has established a subsistence mitigation fund protocol with Nuiqsut.

The declines in projected NSB-assessed values because of capital depreciation of petroleum infrastructure and the resulting property tax revenue are expected to continue, at least in the short term. For example, from 2006-2009, NSB-assessed valuation is projected to decline from approximately \$8 billion to \$6

billion, while property tax revenues are projected to decline from \$150 million to \$120 million. Other sources of revenue to the Borough are not expected to compensate for the decline. As newer and more efficient types of development come on line and as older methods and facilities are phased out, the tax base of the NSB could decline further. Future assessed values could be higher, depending on development of potential projects, such as Liberty and the natural gas pipeline and the assessed value of any new infrastructure associated with these projects (Northern Economics, Inc., 2006). The value of these facilities would help to moderate the corresponding decline in NSB expenditures for the range of services it provides to communities.

Twenty-seven percent of all OCS leasing, rental, and royalty receipts, within the first 3 mi of the Alaska OCS, go to the State of Alaska. Also, subsistence-impact funds administered by the U.S. Coast Guard under the Oil Pollution Act of 1990 would be available, in the event of an oil spill, to provide for subsistence-food losses (USDOI, MMS, 2007d).

Beneficial cumulative effects could come from the potential development of local offshore and onshore natural gas resources that could serve as a needed cost-effective local power source (USDOI, MMS, 2007c).

4.4.1.15.2.11. Potential Effects from Climate Change. Potential effects from climate change on subsistence resources and practices were discussed in Sections 4.4.1.12.1.9 and 4.5.1.12.1.9 for the Beaufort and Chukchi seas no-action alternatives. Potential effects from climate change on sociocultural systems were discussed in Sections 4.4.1.13.1.8 and 4.5.1.13.1.8 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Among the Fourth IPCC Synthesis Report (2007) conclusions with relevance for public health in the 21st century Arctic are: (1) the likelihood of more frequent extreme heat waves and heavy precipitation events; (2) widespread increases in permafrost thaw depth; (3) shrinking summer sea ice; (4) increased precipitation at high latitudes; and (5) more rapid sea level rise. Regarding public health, the report predicts that globally, the health status of millions of people will be affected “through, for example, increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrheal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas...; and altered spatial distribution of some infectious diseases” (IPCC, 2007).

The U.S. Climate Change Science Program (CCSP) recently published the “Synthesis and Assessment Product 4.6” (SAP 4.6), an assessment of the likely health effects of climate change in the U.S. (CCSP, 2008). Overall, this report found: (1) it is very likely that heat-related morbidity and mortality will increase over the coming decades; (2) urban areas are likely to suffer increases in tropospheric ozone concentrations that can “contribute to or exacerbate cardiovascular and pulmonary illness if regulatory standards are not attained;” (3) “Hurricanes, extreme precipitation resulting in floods, and wildfires also have the potential to affect public health through direct and indirect health risks;” (4) “There will likely be an increase in the spread of several food and water-borne pathogens among susceptible populations depending on the pathogens’ survival, persistence, habitat range and transmission under changing climate and environmental conditions;” and (5) “climate change is very likely to accentuate the disparities already evident in the American health care system” (CCSP, 2008).

The SAP 4.6 reports a number of specific problems to which Alaska communities are particularly vulnerable, including: (1) extreme precipitation, resulting in contaminated water and food supplies in areas with outdated water treatment plants; (2) wildfires resulting in degraded air quality contributing to

asthma and COPD; and (3) “fewer cold waves and higher minimum temperatures” which could reduce cold-related injury. The report cites current impacts of climate change, including an example from Alaska, where an outbreak of diarrhea caused by shellfish-associated *V. parahemolyticus* in 2004, attributed to the warmest average daily water temperatures recorded in the region (CCSP, 2008). The report also highlights the vulnerability of Alaskan coastal community infrastructure to flooding and permafrost melting (CCSP, 2008). Perhaps most importantly, the report points out that Alaska Native people in coastal communities are among the most vulnerable to the impacts of climate change not only because of the pronounced effects of climate change on the Arctic physical environment and climate but also because of their “decreased economic capacity to prepare for and respond to the impacts of change.”

The Arctic Climate Impact Assessment (ACIA) analyzed the potential impacts of Arctic climate change on the health of Arctic residents. The report notes the potential that temperature changes (the most probable of which is less extreme cold in winter) could lead to decreased cardiovascular and cerebrovascular events and strokes, and decreased cold injury. Increased heat-related morbidity and mortality could also occur though extreme heat events are not as likely in the Arctic as they are at lower latitudes and in large urban centers (Berner et al., 2004). Ozone depletion has long been observed in polar regions, and appears to be increasing. The report discusses the likely contribution of warmer temperature to ozone depletion, and the risks—possible increases in skin cancer and lymphoma, and decreased immune function (Berner et al., 2004). The ACIA also discussed more complex pathways through which health could be impacted by climate change. For example, climate change has already adversely impacted: (1) public health infrastructure (such as solid waste, wastewater, sanitation, and water supply systems, and housing), and this trend is expected to increase; and (2) reduced availability of historically important subsistence species could adversely impact culture, social systems, and health and wellbeing in Arctic communities. Unpredictable increases in new species (such as salmon) could offset the loss of key subsistence species, but would not reduce the cultural significance of a sudden change in availability of a historically important species (Berner et al. 2004).

NSB residents have also observed that the melting of ice cellars has made more frequent hunting trips necessary. Where in the past, for example, a hunter might have brought back a large number of caribou, increased spoilage is now necessitating much more frequent trips. In turn, this represents a large increase in the costs of participating in subsistence, as each trip requires more fuel and creates more wear and tear on equipment.

4.4.1.15.3. Mitigation Measures. Potential adverse impacts on subsistence resources and practices and sociocultural systems would be experienced primarily by the subsistence-dependent minority Iñupiat population. Potential adverse effects on subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated, through applicable regulations and other required mitigation measures. To the extent that applicable regulations and other required mitigation measures do not reduce or avoid the impacts identified, some disproportionate impacts on minority and low-income populations would occur.

The MMS final rule published in the *Federal Register* on April 13, 2007 (Volume 72, Number 71, pages 18577-18585) requires OCS lease owners/operators to provide information on how they will conduct their proposed activities in a manner consistent with the provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Avoidance planning, stipulations and required mitigation measures under MMPA authorization are defined by NMFS and FWS and would serve collectively to mitigate disturbance effects on Alaska Native lifestyles and subsistence harvests and could therefore mitigate impacts on general health and wellbeing, psychosocial problems, diet and nutrition, and diabetes and related metabolic disorders. The efficacy of these measures would be proportional to their efficacy at preventing losses of subsistence harvest.

Onshore, BLM implemented new measures targeting newly identified health effects. These include:

- A measure would help ensure that for any future development and production activities, BLM would undertake an adequate evaluation of potential health effects, in concert with accepted sources of expertise and authority on Alaska Native health. To the extent that this recommendation leads to enforceable or voluntarily implemented measures that address any identified health effects, it would prove effective in preventing adverse impacts to health, and in ensuring the maximum benefits of NPR-A development for local communities.
- A measure to help ensure that the human populations that rely on the planning area for much of their food would not be exposed to harmful levels of oil development-associated contaminants and would limit the risk of contaminant-associated disorders (such as cancers, birth defects, neurodevelopmental delay, and endocrine disorders).
- Expansion of the requirements for an orientation program to include health-related information. To the extent that the orientation program is effective in modifying personnel behavior, effects of drug and alcohol importation and infectious disease transmission may be reduced.

The NSB and MMS entered in an MOU for the purposes of addressing the potential public health effects of Arctic OCS leasing. Several potential new mitigation measures to address potential health issues were developed by NSB and submitted for MMS consideration. The MMS and NSB have agreed to a series of work sessions to consider these proposed measures. The NSB's proposed mitigation measures are provided in Appendix J.

Environmental Studies and Initiatives related to Environmental Justice. The Alaska OCS Region promotes studies that directly address the standing issues and concerns of Native stakeholders. The MMS involves local and Tribal governments in its studies-planning process and has held meetings in all local communities to assist their involvement in this effort. The MMS' participation in the newly formed North Slope Science Initiative ensures MMS' continued involvement in Slopewide scientific research formulation and coordination.

Particular studies that MMS has funded to address sociocultural and EJ impacts include: the MMS' Bowhead Whale Feeding Study, conducted out of the village of Kaktovik, that included local Inupiat in the study design, data gathering, and data analysis; a component of the *Arctic Nearshore Impact Monitoring in Development Areas (ANIMIDA)* study (designed specifically to meet requests from the Inupiat community) funded a multiyear study of Cross Island whaling to assess the historic and ongoing subsistence use of the area surrounding Cross Island by working with local whale hunters. North Slope whalers (and, to a more limited extent, AEWC and NSB staff) have had a role in formulating and implementing this project. The follow-up study, *Continuation of Arctic Nearshore Impact Monitoring in Development Areas (CANIMIDA)* will monitor whaling for long-term industry effects in Wainwright. The recently completed *Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting/Subsistence Activities in the Beaufort Sea* study assessed the perceptions of Inupiat whaling captains and elders as related to oil and gas industry impacts on Inupiat culture and subsistence practices; the *Alaska Marine Mammal Tissue Archival Project, the Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow: Past and Present Comparison* study; and the *North Slope Borough Economy, 1965 to Present* study are other studies that address subsistence, sociocultural and EJ impacts.

One study that particularly tried to address seismic noise effects was the *GIS Geospatial Database of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea*, completed in 2002. This study was initiated to compile detailed information describing the locations, timing, and nature of oil- and gas-related and other human activities in the Alaskan Beaufort Sea. An important objective of the database was to assess concerns expressed by subsistence hunters and others living within the coastal villages of the Beaufort Sea about the possible effects that oil and gas activities (particularly seismic

activity, drilling, and oil and gas support-vessel activities) had on the behavior of marine mammals, especially the bowhead whale. The Human Activities Database, however, is proprietary because it includes sensitive oil and gas industry data. With the exception of ice-management activity, the compiled information for the period 1990-1998 is relatively complete and considered adequate for the investigation of potential effects of disturbance on the fall bowhead whale migration. However, there are significant gaps in the data for the period 1979-1989. This initiative continues under the ongoing study *Analysis of Covariance of Human Activities and Sea ice in Relation to Fall Migrations of Bowhead Whales*.

Alaska initiatives researching contaminants in subsistence foods include a 1999 report by the Alaska Native Health Board: *Alaska Pollution Issues*. After assessing the risks from radionuclides, persistent organic pollutants, heavy metals, PCBs, dioxins, and furans, the Health Board report concluded that the “benefits of a traditional food diet far outweigh the relative risks posed by the consumption of small amounts of contaminants in traditional foods” (Alaska Native Health Board, 1999). A 1998 report, *Use of Traditional Foods in a Healthy Diet in Alaska: Risks in Perspective*, by the Alaska Department of Health and Social Services essentially came to the same conclusion as the Native Health Board report. It did suggest that Alaska has a critical need to examine human biomarkers of PCB exposure and that more studies on PCB concentrations in the serum of Alaskan Natives is needed. Such information would be the most relevant in determining PCB exposure through the subsistence food chain. A comprehensive Statewide screening study was advocated (Egeland, Feyk, and Middaugh, 1998).

Another important way MMS has tried to address Native concerns has been to include local Inupiat Traditional Knowledge in the text of lease-sale and production EISs. This process was followed for Sale 170 in 1997, and for all succeeding EAs and EISs.

More recent MMS studies that address sociocultural and environmental justice impacts include: (1) *Dynamics of Distribution and Consumption of Subsistence Resources in Coastal Alaska*; (2) *Researching Technical Dialogue with Alaskan Coastal Communities: Analysis of the Social, Cultural, Linguistic, and Institutional Parameters of Public/Agency Communication Patterns*; (3) *Analysis of Variation in Abundance of Arctic Cisco in the Colville River* (this study has a Traditional Knowledge component); (4) *Monitoring the Distribution of Arctic Whales*; (5) *Bowhead Whale Feeding in the Central and Western Alaska Beaufort Sea*; (6) *Aerial Photography of Bowhead Whales to Estimate the Size of the Western Arctic Population*; (7) *Satellite Tracking of Eastern Chukchi Sea Beluga Whales in the Beaufort Sea and Arctic Ocean*; and (8) *Development of Remote Sensing Survey Techniques for Arctic Marine Mammals: Pacific Walrus*.

Perhaps more importantly, MMS has recognized the importance of local consultation and the important role that the NSB and other local organizations and institutions can play in the development and evaluation of specific actions. Further, MMS now routinely includes Native representation on the Scientific Review Boards for its major projects. George Ahmaogak, former Mayor of the NSB, has been a member of MMS’ OCS Policy Committee. Other initiatives include an MMS-sponsored Information Transfer Meeting (ITM) in Anchorage in January 1999 and the Beaufort Sea Information Update Meeting in Barrow in March 2000, which presented updates on research and studies being conducted in the Beaufort Sea. The March 1999 meeting included presentations by Barrow, Nuiqsut, and Kaktovik whaling captains. In early 2005, MMS held an ITM in Anchorage and a mini-ITM in Barrow. In October 2005, MMS held a Chukchi Sea Science Update Meeting in Anchorage to update its analysts for their work on Sale 193 on the current information base and conditions for oceanography and marine mammal, fish, bird, subsistence, and sociocultural resources. The meeting’s other purpose was to develop a studies regime for these resources in the region. Just recently, an MMS ITM was held in October 2008 in Anchorage.

The MMS Alaska OCS Region homepage also maintains an Alaska Native Links page that provides information on the MMS Traditional Knowledge-incorporation process, information on Barrow whaling, and MMS assistance with the bowhead whale census, as well as links to Alaskan Native sites and U.S. Government Native-related sites. The MMS Alaska OCS Region's community liaison, Albert Barros, was instrumental in getting an Alaska-wide Department of the Interior Memorandum of Understanding (MOU) with Alaskan tribes on government-to-government consultation signed by all the Alaska Department of the Interior Agency Regional Directors. In 2006, MMS, signed an MOU with the tribal government of Kaktovik that formalizes consultation and mutual cooperation between the community and MMS on MMS-specific projects that potentially could impact Kaktovik. Part of this formal cooperation has led to MMS funding the local hire of a Kaktovik environmental liaison position. In 2008, MMS and the NSB signed an MOU that would formalized consultation and review of regional public health concerns in the region, including a narrative on public health included as part of the EIS analysis process.

In terms of oil-spill-response initiatives, the MMS and the NSB are participants in the North Slope Spill Response Project Team that was established to provide areawide spill-response planning for local communities on the North Slope. The MMS has provided the NSB, the AEWG, the Inupiat Community of the Arctic Slope, and local Native villages information on oil-spill planning, response, and cleanup and ongoing spill-response research initiatives.

The MMS has invited local communities and tribal groups to scheduled industry oil-response drills at Prudhoe Bay. Additionally, MMS held an Alaska Arctic Pipelines Workshop on November 8-9, 1999, in Anchorage to facilitate the exchange of technical information and current research on pipelines in the Arctic between the public, regulators, pipeline designers, and operators. The workshop consisted of presentations and breakout sessions on pipeline design, construction, operations, and maintenance. About 150 persons, including NSB representatives, participated in the workshop.

The MMS encourages initiatives to train village oil-spill-response teams as a way of guaranteeing local participation in spill response and cleanup; this effort allows local Native communities to use their traditional knowledge about sea ice and the environment in the response process. Within the constraints of Federal, State, and local law, operators and Alaska Clean Seas are encouraged to hire and train residents of local Beaufort and Chukchi Sea communities in oil-spill response and cleanup.

The MMS has worked with the oil industry to develop a comprehensive plan for dealing with subsistence claims, should an oil spill occur. At the present time, the U.S. Coast Guard is reworking their claim process to be more responsive to Native subsistence practices in Alaska. The MMS requires all operators to provide financial responsibility through bonds as required by the Oil Pollution Act of 1990, to ensure they have the means to clean up an oil spill.

Other potential mitigation available if activity occurs includes potential staging of oil-spill equipment at critical locations to support any necessary oil-spill-cleanup operations. This initiative would address response-readiness concerns of subsistence users. Also, the staging of boom material and other pertinent response equipment at Barrow, Cross Island, and Kaktovik and Chukchi Sea communities would provide protection to critical whaling and other marine mammal hunting areas and shoreline. These measures could be included in the oil-spill-contingency plan or in the final Condition of Permit approval letter for a production project issued by the Regional Supervisor for Field Operations.

The oil-spill-contingency plan also could include tactics for protecting bowhead whales. Hazing also could divert bowhead whales away from a spill if they happened to be in the area at the time of an oil spill.

The MMS acknowledges that present mechanical-cleanup technology has not demonstrated cleanup ability in broken-ice conditions. In situ burning is a nonmechanical response method available for spill response and could be quite effective in ice conditions, where mechanical cleanup techniques have been proven problematic. Collectively, standard stipulations, NTLs, and ITLs, along with the other rules and regulations governing offshore activities permitted by MMS would aid substantively in mitigating against contamination to onshore habitats and subsistence resources.

Since July 2003, MMS and the NSB have been in constant consultation and coordination on a number of issues that include conflict avoidance, oil-spill-risk analysis, peer review of scientific studies, and disturbance effects on subsistence resources, cumulative effects recommendations of the 2003 NRC (2003) Report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*, bowhead whale feeding in the Beaufort Sea, deferral area boundaries, and ways to improve stakeholder communication. This ongoing dialogue may result in development of new mitigation, scientific studies, and avenues of cooperation (USDOJ, MMS, 2004).

Onshore, the oil industry, in coordination with the community of Nuiqsut, has established and partially funded a Subsistence Oversight Panel to field the concerns of local subsistence hunters and to monitor local subsistence resources. If offshore development occurs, MMS will explore ways to support this or other similar panels (USDOJ, MMS, 2003a).

When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Inupiat people continue to value the land deeply as a foundation of well-being and culture, any measure that contributes to minimizing the environmental impacts of development in the region could be seen as contributing positively toward overall health and well-being. In terms of NPR-A leasing, North Slope residents and the NSB have expressed a great deal of concern that the new “adaptive management” strategy adopted for the Northeast NPR-A may result in considerable weakening of protections for the area, and will create a situation of perpetual flux and uncertainty as the increased flexibility offered under the new system creates the opportunity for important protections to be overridden by economic and industry concerns. From the local perspective, the entire adaptive management program may be seen as a significant stressor, with potential attendant health problems as described above in the social determinants of health section (USDOJ, BLM, 2005).

Efforts to address cumulative impacts include a November 2001 meeting of the MMS OCS Policy Committee, where they discussed the need for the USDOJ to find a way to provide funds to Tribal and local governments for training and travel needs to facilitate their participation in USDOJ planning and decision making processes. Without funding, these executive orders are perceived by the Native community simply as new “unfunded mandates.” Funding of this nature would ameliorate some of the stresses caused in small Native villages from the burden of participation in the agency public process.

More specifically, and based on Native stakeholder concern, MMS has addressed cumulative impacts by redesigning its approach to oil-spill risk to make its methodology better suited to the Arctic region. Also, based on stakeholder concern, the MMS has redesigned its EIS analysis of cumulative effects. These changes are reflected in all EIS analyses since the Liberty final EIS in May 2002.

In April 2001, MMS held The Bowhead Whale Subsistence Hunt and Outer Continental Shelf Oil and Gas Activities Research Design Workshop in Anchorage. This workshop was requested by the NMFS and the AEWC to better focus scientific research on the cumulative effects of OCS activity on bowhead whales and their migration, in addition to the sociocultural dimensions of the subsistence whale hunt. Recommendations from the workshop identified: (1) the need for extensive funding to effectively study the complex relationship between OCS and onshore socioeconomic effects; (2) the need for effective monitoring to document and analyze industry and whaling activities and the many factors of change in

local communities; (3) that defining and disaggregating (on and offshore) cumulative social effects will be a difficult process; and (4) that defining the relative causal effect of any given factor, such as OCS oil and gas activity, on social problems is problematic. Participants agreed that available resources would better be applied to researching means of prevention, intervention, and treatment of social problems in North Slope Native communities.

The ongoing *Sociocultural Consequences of Alaska OCS Activities: Data Analysis/Integration* study is a cooperative agreement with the ADF&G, Subsistence Division to analyze and integrate subsistence, socioeconomic, and sociocultural time-series data from previous MMS-sponsored projects to assess the occurrence and implications of sociocultural change from OCS activities.

The National Academy of Sciences conducted a multiyear *Cumulative Environmental Effects of Alaskan North Slope Oil and Gas Activities Study* under the direction of Dr. David Policansky. The committee of national, State, and local experts reviewed information about oil and gas activities (including exploration, development, and production) on Alaska's North Slope. Based on the review, the committee assessed the known and probable cumulative impacts of oil and gas activities from the early 1900s to the present (including cleanup efforts) on the physical, biological, and human environments of Alaska's North Slope (including the adjacent marine environment). It provided an assessment of potential future cumulative effects, based on likely changes in technology and the environment and a variety of scenarios of oil and gas production—all in combination with other human activities, including tourism, fishing, and mining. The committee described and documented its methodology for assessing cumulative effects and identified gaps in knowledge and made recommendations for future research needed to fill those gaps. The MMS and other Federal and State agencies conducting oil activities on the North Slope are working to implement the recommendations of this study that specifically advocates for “a slope-wide, jurisdictionally coordinated framework for wildland evaluation, mapping, ranking, impact analysis, and planning [that] would help decision-makers identify conflicts, set priorities, and make better-informed decisions” (NRC, 2003b).

Specific research needs and approaches identified by the NRC study include: (1) targeting how much oil and gas activities are associated with rising levels of sociocultural change; (2) conducting more culturally and locally cooperative research by incorporating more traditional and local knowledge into research study designs; (3) focusing on translating theoretical research “concepts and values into concrete terms” that can better be used in environmental assessment; and (4) better identifying the physical, psychological, cultural, spiritual, and social human-health effects of oil and gas development on North Slope residents (NRC, 2003b).

More recent ongoing and proposed research and sovereignty initiatives regarding cumulative impacts to the indigenous populations in the Arctic and Native populations on the North Slope include:

- The Second International Conference on Arctic Research Planning (ICARP-2) that met in April 2005 to develop a plan to study the resilience and vulnerability of rapid change to local communities in the Arctic.
- A U.S. Census Bureau report, *We the People: American Indians and Alaska Natives in the United States*, that provides a portrait of the demographic, social, and economic characteristics collected from Census 2000 of indigenous American populations and discusses specific tribal groupings, reservations, and Alaskan Native village statistical areas.
- *Food Security in Arctic Alaska: A Preliminary Assessment* (Caulfield, 2000) that advocates for a better understanding of subsistence-food security, more up-to-date research to determine country foods types, pricing, transportation systems, and a better understanding of relevant laws, policies, and controlling institutions.

- *Human and Chemical Ecology of Arctic Pathways by Marine Pollutants* (O’Hara et al., 2002) that will document reliance by indigenous arctic marine communities in Canada, Alaska, and Russia on arctic resources at risk from chemical pollutants and incorporate traditional knowledge systems on subsistence harvests.
- The *Arctic Human Development Report* developed by the Arctic Council in 2005 to provide an overview of human development in the Arctic, identify critical data gaps, establish priorities for sustainable development, and shed light on the dimensions of human well-being in the region.
- *Vital Arctic Graphics Report* (UNEP, 2006) that identifies critical arctic ecosystems in order to protect important indigenous regions and food sources to ensure sustainable development in the region.
- A subsistence-foods study, *The Contribution of Subsistence Foods to the Total Diet of Alaska Natives in 13 Rural Communities*, funded by the Agency for Toxic Substances and Disease Registry, conducted by Ballew et al. Researchers confirmed, as many other studies have before, that subsistence foods make up a large part of the total Alaskan Native diet. They quantified subsistence-food intake and set the stage for the long-term goal of the study, which is to evaluate the health benefits and risks of consuming subsistence foods in order for people to make more informed food choices. They were unable to quantify the economic balance of subsistence and purchased foods. They reiterated that the data to assess exposure to contaminants in subsistence foods were inadequate because many traditional foods have yet to be tested. They concluded that testing of the foods that people consume most should be the highest research priority (Ballew et al., 2006).

The MMS funded the Nuiqsut-based study *Analysis of Variation in Abundance of Arctic Cisco in the Colville River*, which sponsored a local workshop in Nuiqsut for Traditional and Western science experts on arctic cisco to answer questions about arctic cisco abundance. The proceedings of this workshop were published in the MMS Study Report MMS 2004-033. Separate Traditional Knowledge (completed by residents of Nuiqsut) and Western Science reports were final products of this study.

Indigenous initiatives to address Arctic issues include the formation of an alliance of grass-roots Native activists called Resisting Environmental Devastation on Indigenous Lands (REDOIL) to confront oil and gas development issues in Alaska. This alliance condemns extractive industries and the Alaska Native Claims Settlement Act (ANCSA) and has come together to address aboriginal, economic, and environmental justice issues concerning the roles of corporations, the State of Alaska, and the Federal Government in oil and gas development (Dobbyn, 2003). In April 2006, the Indigenous Peoples and Nations Coalition sent a petition to the United Nations challenging U.S. title to Alaska and Hawaiian Native lands, referring the situation to the proper United Nations agencies, “so that the rights of the Indigenous Peoples can be vindicated, including the right to self-government and to enjoyment of their natural resources” (Alaska Inter-Tribal Council, 2006).

Local governments and stakeholders have encouraged the development of a standing interagency/intergovernmental working group that would include local and regional North Slope and northwest Arctic governments, State and Federal land management agencies, and industry to consult, coordinate, design, and monitor solutions to subsistence and sociocultural cumulative impacts on- and offshore. Their scoping comments suggest that such a body would better serve the concerns of subsistence hunters and lead to more balanced decisions on approaches to long-term monitoring and the proper assessment of oil-activity cumulative impacts on subsistence resources and harvests and Inupiat culture.

The formation of the North Slope Science Initiative Science (NSSI) Technical Group in February 2006 bodes well for addressing these local concerns and for developing better protocols for assessing

cumulative impacts on Alaska's North Slope. This 15-member group, composed of Federal, State, local, and industry leadership, is tasked with developing a consistent scientific approach to North Slope research and is the most likely group to develop and implement research, monitoring, and mitigation regimes that will address community impacts from North Slope oil exploration and development (*Petroleum News*, 2006).

While these efforts in themselves would not resolve the larger problems of ongoing cultural challenge to Inupiat traditions from increasing development in the region and from the powerful influences of modernity, such as cable television, the Internet, and an increasing dependence on a wage-based economy, they do provide processes for information sharing and opportunities for mutual decision making and remediation of cumulative social and subsistence impacts.

The BLM, in support of its onshore NPR-A leasing activities, has funded studies of caribou and waterfowl habitat use and behavior on the North Slope. Other researchers are looking into how exploration and development on the North Slope could impact traditional lifestyles and values (USDOI, BLM, 2004).

The extent to which mitigation will prevent or reduce environmental justice and human health impacts will be proportional to: (1) the degree to which it is enforced to protect the local environment; (2) the degree to which it prevents impacts to subsistence resource populations, displacement of subsistence resources, and displacement of hunters and their families; (3) the efficacy of controls on environmental contamination and on measures taken to reassure communities, regarding their concerns about environmental contamination; and (4) the degree to which it prevents the adverse consequences of sociocultural change and supports the positive aspects associated with employment and economic opportunity. In the face of expanding development, particularly with the development of important onshore subsistence areas, it is likely that there could be substantial unmitigated impacts to health and the social determinants of health.

Locally, the NSB and the NWAB have convened two joint Arctic Economic Development Summits to address the region's economic future, increase the availability of local jobs, and develop strategies to enhance the future well-being and success of Inupiat children through better education (Community Engagement Steering Committee, 2005).

Over the 3 decades of MMS involvement in the Arctic, local communities have been very vocal about finding a "compensation" source—impact assistance, revenue sharing, bonds, or mitigation payments—to address impacts from OCS activities. Without congressional authorization, MMS cannot provide or require industry to provide such compensation. Federal Agencies cannot commit to impact assistance because that is a role of Congress and not the Executive Branch. Only Congress can alter the OCS Lands Act to include provisions for local impact assistance from MMS revenues or provide the authorization for funding such revenues. Nevertheless, in response to this critical concern, Department of the Interior and MMS staff have drafted legislative language on this subject in response to congressional requests. Furthermore, the MMS OCS Policy Committee has developed a white paper on impact assistance and revenue sharing options and has shared this paper and its findings with concerned policymakers (USDOI, MMS, 2007d). Alaska Senator Ted Stevens has publicly articulated the need for coastal impact assistance to local coastal communities funded by MMS lease-sale revenues (Hopkins and Bolstad, 2008).

In 2001, Congress appropriated impact-assistance funds for coastal states affected by OCS oil and gas production. Nationwide, Congress appropriated \$150 million to be allocated among eligible oil- and gas-producing states. Alaska received an appropriation of \$12.2 million, \$1,939,680 of which went to the NSB, and \$102,530 went to the NWAB. The Coastal Impact Assistance Program (CIAP) was reauthorized by Congress under the Energy Act of 2005. Under the new CIAP, \$250 million for each of

fiscal years 2007 through 2010 will be disbursed directly to eligible producing states and to qualifying counties, parishes and boroughs within those states. Under the new CIAP, states eligible to receive funding are Alabama, Alaska, California, Louisiana, Mississippi, and Texas. The CIAP funds will be allocated to these states based on the proportion of qualified OCS revenues offshore of the individual state to total qualified OCS revenues from all states; thirty-five percent of this money will go to local communities. Because Alaska currently lacks significant OCS production, historically its contribution to total OCS revenues was much less than the other states. Consequently, for FY2007 and FY 2008, Alaska will receive the minimum allocation provided under the program, or \$2.5 million for each year. Of this amount, the NSB will receive over \$275,000 per year and the NWAB over \$235,000 per year. These amounts, however, will rise significantly during the last 2 years of the CIAP program because of Chukchi Sea Sale 193, held February 6, 2008. Sale 193, which was the largest Alaska OCS sale in history, brought in over \$2.6 billion to the U.S. Treasury. As a result, Alaska's share of CIAP revenue will rise more than 10-fold in FY 2009 and FY 2010, along with a corresponding increase in revenues for the two boroughs. Final allocation numbers for FY 2009 and FY 2010 will be known by early spring 2009 (USDOJ, MMS, 2007d).

4.4.1.15.4. Traditional Knowledge on Effects from Disturbance, Discharges, Oil Spills, Oil Spill Response and Cleanup, Seismic Surveys, Other Sources, and Climate Change.

Traditional Knowledge on Effects from Vessel and Aircraft Disturbance, Discharges, Large Oil Spills and Cleanup, Small Oil Spills, Seismic Surveys, Other Sources, and Climate Change as it applies to EJ concerns for both Chukchi and Beaufort seas subsistence communities appears in Section 4.4.1.12.3. Sociocultural-specific traditional knowledge as it applies to Beaufort and Chukchi seas communities was discussed in Sections 4.4.1.13.3 and 4.5.1.13.3 of the Beaufort and Chukchi seas no-action alternatives.

The Iñupiat people consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a pivotal part of their culture in addition to being a favored food source (Brower, 1976; Itta, 2001). A major oil spill on the North Slope would result in effects that would impact Iñupiat subsistence users more than any other human group (USDOJ, BLM, 2005).

Onshore, North Slope residents have noted the decline of fish populations caused by seismic activities, the diversion of caribou from traditional migration routes and calving areas caused by an increased number of low-flying aircraft, the disruption of caribou movements by low pipelines, and the ending of use of traditional harvest areas due to the avoidance of industrial areas by hunters. Oil and gas development in the Prudhoe Bay and Kuparuk areas has discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (USDOJ, BLM, 2005).

4.4.1.15.5. Anticipated Level of Cumulative Effects Under Alternative 1. Anticipated effects on sociocultural systems were discussed in Section 4.4.1.13.7 of the Beaufort Sea no-action alternative. Potential effects on sociocultural systems were described in Section 4.4.1.13.1. The potential effects to subsistence-harvest patterns were described in Section 4.4.1.12.1. This section describes the impact on EJ resulting from the incremental impact of the no-action alternative and adding it to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such actions. Past and present cumulative actions are described below as they have impacted specifically affected EJ. Reasonably foreseeable future actions are described in Section 4.2. To the extent that these actions impacted subsistence resources and practices and sociocultural systems, they would have consequent impacts on EJ. These consequences will be discussed in the cumulative past and present action discussions below for specific impactors. Mitigation measures are described in Sections 4.4.1.12.2, 4.4.1.13.2, and 4.4.1.15.3. This section describes the impact on public health resulting from past, present, and reasonably foreseeable future actions regardless of what agency or entity undertakes such actions. Alternative 1, No Action,

would have no incremental contribution to cumulative EJ effects, except for those discussed under Economics. This section incorporates BLM's review of past and present cumulative effects on public health from the recent Northeast NPR-A Amendment FEIS (USDOJ, BLM, 2008).

Ongoing projects in the region are summarized in Section 4.2.1, and include: (1) ongoing maintenance and development projects in local communities; (2) onshore oil and gas infrastructure development; (3) passenger, research, and industry-support aircraft activities; (4) local boat traffic, barge resupply to local communities, research vessel traffic, industry-support vessel activities (mostly in support of seismic surveys), an increasing U.S. Coast Guard presence, and vessel traffic from increasing ecotourism in the Arctic. Ongoing actions include: (1) development and production activities at Endicott, Northstar, Badami, and Alpine; (2) recent leasing from Beaufort Lease Sales 195 and 202; (3) State leasing; and (4) onshore leasing activity in the NPR-A. Other projects include BP's restart of the Liberty Development Project east of Endicott; Pioneer Natural Resources Co.'s development of its North Slope Oooguruk field in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit; and the Nikaitchug Development Project also in State waters off the Colville Delta. In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling off the Mackenzie River Delta, and GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area (USDOJ, MMS, 2006a).

Impacts to subsistence resources and harvests from existing and planned oil and gas exploration and development; potential increased boat traffic from ecotourism and commerce in the Arctic; environmental contamination; influx of nonresident workers and ecotourism; staging for OCS activities from shorebases, airstrips, and communities; and on-going changes in the Arctic climate, will have impacts on public health in the NSB in the foreseeable future. Onshore development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from nonsubsistence hunters for fish and wildlife (Haynes and Pedersen, 1989). Additive impacts that could affect subsistence resources include potential oil spills; seismic noise; road and air traffic disturbance; and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas farther from the local subsistence communities would require increased effort, risk, and cost on the part of subsistence users. Increasing the amount of onshore area open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence-harvest efforts in the undeveloped areas and increasing the potential for conflict over harvest areas within a community (USDOJ, BLM, 2005).

4.4.1.15.5.1. Anticipated Level of Cumulative Effects from Disturbance. Anticipated effects from disturbance on subsistence resources and practices were discussed in Sections 4.4.1.12.4.1 and 4.4.1.12.4.2 for the Beaufort Sea no-action alternative and Sections 4.5.1.12.4.1 and 4.5.1.12.4.2 for the Chukchi Sea no-action alternative. Anticipated effects from disturbance on sociocultural systems were discussed in Sections 4.4.1.13.4.1 and 4.5.1.13.4.1 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects on environmental justice from disturbance were discussed in Section 4.4.1.15.5.1. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population. The potential effects on public health from disturbance were discussed in the potential effects discussion above.

Cumulative past and present actions related to vessel and aircraft disturbance effects on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7 for the Beaufort and Chukchi seas no-action alternatives. Cumulative effects on sociocultural systems were discussed in Sections

4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

Effects on public health from disturbance derive primarily from impacts to subsistence resources are discussed in Section 4.4.1.12. These actions would be expected to impact public health—particularly general health and wellbeing, nutrition and diet, and chronic diseases such as diabetes, high blood pressure, and cardiovascular disease—to the extent that subsistence resources are impacted. The cumulative effects on bowhead whale migration are a particular concern and could lead to a decreased subsistence harvest and even potentially to quota restrictions by the IWC if the effects of industrialization increase the cumulative threat to the species. Any substantial decrease in bowhead whale harvest would constitute a major impact on public health. Alternative 1, the No Action Alternative, would not contribute substantially to the cumulative effects on public health from disturbance.

4.4.1.15.5.2. Anticipated Level of Cumulative Effects from Discharges. Anticipated effects from discharges on subsistence resources and practices were discussed in Sections 4.4.1.12.4.3 and 4.5.1.12.4.3 for the Beaufort and Chukchi seas no-action alternatives. Effects from discharges on sociocultural systems were discussed in Sections 4.4.1.13.4.2 and 4.5.1.13.4.2 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from disturbance were discussed in Section 4.4.1.15.2.1. See also the general discussion on anticipated effects to EJ in Section 4.4.1.16.3.5 above. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population. Effects on subsistence resources from exploration were projected to be minor to moderate. As delineated above, however, the acknowledged data gaps regarding the fate and impacts of OCS discharges on Arctic subsistence species is a source of considerable concern in NSB communities.

Discharges could lead to a perceived risk of contamination that would adversely impact residents' confidence in the safety of the food supply, alter harvest and consumption patterns, and increase the risk of nutritional deficiencies, food insecurity, and chronic diseases such as diabetes, high blood pressure, and cardiovascular disease—a major effect. Contaminants associated with oil and gas activities are associated with a range of public health problems, including cancer and neurodevelopmental delay, as described under potential effects. Alternative 1, the No Action Alternative, would not contribute substantially to the cumulative effects on public health from discharges.

Mitigation could reduce the adverse effects from discharges on public health. Onshore, the BLM's new ROP A-11 will provide subsistence users with valuable information regarding the levels of contaminants in land-based resources, and would provide a mechanism to ensure a regulatory response if levels of local contaminants were found to reach levels that could harm subsistence users.

4.4.1.15.5.3. Anticipated Level of Cumulative Effects from Oil Spills. Anticipated effects from oil spills on subsistence resources and practices were discussed in Sections 4.4.1.12.4 and 4.5.1.12.4.4 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from oil spills on sociocultural systems were discussed in Sections 4.4.1.13.4.3 and 4.5.1.13.4.3 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from oil spills were discussed in Section 4.4.1.16.4.3. Anticipated effects from small oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.4.5. See also the discussion on anticipated effects to sociocultural systems from large oil spills in Section 4.4.1.13.4.4. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Potential effects on public health from large oil spills were discussed above in the potential effects discussion.

Cumulative effects from small oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.7 and would be expected to impact environmental justice to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

The effects from large oil spills on subsistence resources and practices were discussed in Section 4.4.1.12.4.4 and the effects from large oil spills on sociocultural systems were discussed in section 4.4.1.134.3. A large oil spill could adversely affect public health and would be expected to impact sociocultural systems to the extent it adversely impacted subsistence harvests and practices. Following the EVOS, communities experienced increases in post-traumatic stress disorder, depression, anxiety, and stress (Palinkas et al., 1993; Palnikas et al., 2004), decreased social interconnectedness (or social capital) (Ritchie and Gill, 2004), and decreased subsistence harvests of many resources that persist to this day (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999; USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003). The effects of contaminant-related health effects related to an oil spill are difficult to study. For example, exposure to benzene and other HAPs near a spill could be high enough to increase the risk of rare cancers such as leukemia. However, because of the small population size in NSB villages, linking a change in incidence of such a cancer to an environmental exposure is statistically difficult. Nevertheless, for contaminants with well-characterized toxicological profiles such as benzene and specific PAHs, exposure is known to produce adverse health effects, and should be considered a major adverse health effect of a large spill if individuals or communities are exposed. Alternative 1, the No Action Alternative, would not contribute substantially to the cumulative effects on public health from large oil spills.

Mitigation could reduce the effects of a large oil spill on public health. Mitigation would not be expected to prevent or eliminate adverse health effects from a large spill but would be a critically important part of an adequate response.

4.4.1.15.5.4. Anticipated Level of Cumulative Effects from Oil-Spill Response and Cleanup. Anticipated effects from oil-spill response and cleanup on subsistence resources and practices were discussed in Sections 4.4.1.12.4.6 and 4.5.1.12.4.6 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from oil-spill response and cleanup on sociocultural systems were discussed in Sections 4.4.1.13.4.5 and 4.5.1.13.4.5 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from oil-spill response and cleanup were discussed in Section 4.4.1.15.2.4. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Cumulative effects from oil-spill response and cleanup on subsistence resources and practices were previously discussed in Sections 4.4.1.12.7. Based on the EVOS, residents employed in cleanup could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs. In the event of a much larger spill, these dramatic changes could cause tremendous social upheaval, with implications for health as described in the potential effects discussion above (Human Relations Area Files, Inc., 1995; ADF&G, 1995b; Impact Assessment, Inc., 1990c, 1998). These changes have important implications for health. The rapid influx of cash, the influx of nonresident workers to and through coastal communities, and short-term and unstable employment increase the risk of infectious disease transmission, potentially compromising the efficacy of local prohibition laws in preventing adverse health effects from alcohol consumption, and could exacerbate social and psychological strain leading to maladaptive behavior, including violence and alcohol and drug abuse. The adverse health effects of insecure or unstable employment are similar to unemployment in

many studies (Marmot and Wilkinson, 2003). Interference with subsistence seasonal activities would have implications for nutritional health and chronic diseases, such as diabetes, but as oil-spill response would be a short-term event, it would not be expected to contribute significantly to the risk of these conditions developing. Alternative 1, the No Action Alternative, would not contribute substantially to the cumulative effects on public health from oil-spill response.

4.4.1.15.5.5. Anticipated Level of Cumulative Effects from Airborne Emissions. Potential effects from airborne emissions on public health were discussed above. Most of the emissions from North Slope development have to date been concentrated in the region of Prudhoe Bay. Emissions from Prudhoe Bay have been detected in Barrow (Jaffe et al., 1995). According to the Alaska DEC:

transport and deposition of pollution downstream of the North Slope facilities may be having a noticeable effect on the environment of the NPR-A. Currently, no data has been collected to document if the substantial amount of pollution emitted on the North Slope, although not in violation of air standards, may be having a significant cumulative effect on this area. (ADNR, 2007)

Monitoring data are not sufficient to allow a determination of the contribution of various sources of emissions to air quality in Barrow or other villages, relative to the contributions of other known sources in Northern Europe and Asia. Alternative 1, the No Action Alternative, would not contribute substantially to the cumulative effects on public health from airborne emissions.

4.4.1.15.5.6. Anticipated Level of Cumulative Effects from Seismic Surveys. Anticipated effects from seismic surveys on subsistence resources and practices were discussed in Sections 4.4.1.12.4.7 and 4.5.1.12.4.7 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from seismic surveys on sociocultural systems were discussed in Sections 4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from seismic surveys were discussed in Section 4.4.1.15.2.6. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population. The potential effects from seismic surveys on public health were discussed in the potential effects discussion above.

Cumulative past and present actions related to effects from seismic surveys on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7 for the Beaufort and Chukchi seas no-action alternatives. Cumulative effects on sociocultural systems were discussed in Sections 4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

The cumulative effects on public health from anticipated impacts of seismic surveys would occur primarily through impacts to subsistence. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas, and the traditional bowhead whale harvest could be adversely affected. The same could be true for beluga whales, walrus, and seals (USDOI, MMS, 2003a). The disruption of whale harvests could result from any potential diversion of the whale migration to further offshore, or from other behavior changes by the animals. The greater the degree of activity onshore and oil and gas development in Federal, State, and Canadian waters, the more probable and more pronounced cumulative effects are likely to be.

4.4.1.15.5.7. Anticipated Level of Cumulative Effects from Habitat Loss. Anticipated effects from habitat loss on subsistence resources and practices were discussed in Sections 4.4.1.12.4.8 and

4.5.1.12.4.8 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from habitat loss on sociocultural systems were discussed in Sections 4.4.1.13.4.7 and 4.5.1.13.4.7 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from habitat loss were discussed in Section 4.4.1.15.2.7. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population. The potential effects from habitat loss were discussed in the potential effects discussion above.

Cumulative past and present actions related to effects from habitat loss on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7 for the Beaufort and Chukchi seas no-action alternatives. Cumulative effects on sociocultural systems were discussed in Sections 4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

The cumulative effects to public health from habitat loss derive mainly from impacts to subsistence. Onshore construction could disrupt increasing areas of subsistence habitat. Health effects would include: (1) increased psychosocial problems, such as stress and anxiety, caused by more difficult and less successful subsistence hunts; (2) increased injury rates from hunters having to travel longer distances to successfully harvest resources; (3) increased food security from less reliable subsistence harvests; and, (4) over time, if subsistence harvest impacts were sustained, increased risk of nutritional deficiencies and chronic diseases such as diabetes, high blood pressure, and cardiovascular disease. An additional concern would be stress and dysphoria caused by the proliferation of industrial infrastructure within view of communities, subsistence camps, and hunting routes. Alternative 1, the No Action Alternative, would not contribute to the cumulative effects on public health from habitat loss.

4.4.1.15.5.8. Anticipated Level of Cumulative Effects from Onshore Development.

Anticipated effects from onshore development on subsistence resources and practices were discussed in Sections 4.4.1.12.4.9 and 4.5.1.12.4.9 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from onshore development on sociocultural systems were discussed in Sections 4.4.1.13.4.8 and 4.5.1.13.4.8 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from onshore development were discussed in Section 4.4.1.15.2.8. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Cumulative onshore development in the vicinity of Nuiqsut related to the Alpine Field and NPR-A leasing could cause long-term displacement and/or functional loss of habitat to the Central Arctic, Teshekpuk Lake, and Western Arctic caribou herds over the life of proposed Alpine development. This could result in significant impacts on access to, and perhaps the availability of, this important subsistence resource. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development were to reduce the availability of resources or alter their distribution patterns (USDOI, MMS, 2006b).

Development is planned for Alpine satellite facilities as well as winter exploration in the area. Seismic exploration would occur in winter and would include the drilling of exploratory and delineation wells in areas not excluded by buffers. Exploration and development could originate from Inigok, Point Lonely, and the Umiat vicinity, and could encompass important subsistence harvest areas for moose, fish, caribou, and furbearers, affecting subsistence users in Nuiqsut and, to a lesser extent, users in Atqasuk, Barrow, and Wainwright. If permanent development is pursued in areas newly opened to exploration and leasing,

Iñupiat users are likely to avoid the area from 5-25 mi around those facilities for subsistence uses (Pedersen et al., 2000; Pedersen and Taalak, 2001).

Potential Delong Portsite development near the Red Dog Mine potentially could affect the take of beluga and bowhead whales by Native hunters from the predominantly Native population at Kivalina. If Portsite development caused harvest of all those marine mammals to be lost, then the community of Kivalina would lose an average of about 12 pounds of beluga and about 48 pounds of bowhead flesh each year, based on recent harvest data. Loss of beluga and bowhead whale flesh and related cultural values would be a disproportionate effect on a minority population (U.S. Army Corps of Engineers, 2005).

Cumulative past and present actions related to effects from onshore development on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7 for the Beaufort and Chukchi seas no-action alternatives. Cumulative effects on sociocultural systems were discussed in Sections 4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

A major concern regarding land management in the western Arctic is that the same pattern of incremental, piecemeal development that has occurred in the central Arctic will be repeated as industry moves westward. In the absence of a comprehensive conservation strategy, expanding industrial development over the next 25-50 years may have significant impacts on individual animal populations, subsistence use opportunities, and the integrity of the greater ecosystem. The Western Arctic Caribou herd can be considered a “keystone” population, in that it provides critical resources for many other species sharing the ecosystem, and it is an important subsistence resource for as many as 40 Native villages within the herd’s annual range (Schoen and Senner, 2003). Therefore, careful consideration must be given to the impact of potential developments to this herd. Cumulative impacts to caribou could be reduced by not allowing leasing in the most sensitive areas; by consolidating facilities (especially reducing the number of roads); by reducing the footprint of development; by prohibiting roads between fields; and by restricting surface and air traffic, humans on foot, and other activities during the calving season. Cumulative oil development is likely to have only local effects on the distribution and abundance of caribou, muskoxen, grizzly bears, and arctic foxes on the North Slope of Alaska and not affect overall distribution and abundance (USDOI, MMS, 2003a; USDOI, BLM, 2004).

As part of the fieldwork protocol for a 1984 MMS technical report titled *Barrow Arch Socioeconomic and Sociocultural Description*, researchers asked people in various Chukchi Sea villages their opinions on building land links between local communities and other regions of the North Slope. The majority of the people interviewed opposed land links to villages because (1) they appreciated the quality of life afforded them by semi-isolation, (2) they believed that roads would have a negative impact on wildlife resources, and (3) they worried that road access would increase liquor imports into “dry” villages (ACI, Courtneage, Braund, 1984).

Traditional knowledge as related by some hunters in northwestern Alaska affirms that construction and operation of the Portsite for the Red Dog Mine has affected the subsistence harvest of belugas in the Chukchi Sea around the Portsite. The total harvest of beluga whales by hunters from Kivalina dropped off between 1984 and 1987, before construction began at the Portsite and has continued to be relatively low. In other marine waters of Alaska, belugas have tended to adapt to industrial and transportation noises after they have learned such noises do not represent a direct threat (Huntington and Mymrin 1996). Reports by Kivalina hunters indicate that either belugas of both spring and summer stocks have not yet become acclimated to structures or activities at the Red Dog Portsite or that other factors have reduced Kivalina’s beluga harvest since construction began in the late 1980s. While data from the Beaufort Sea and Cook Inlet indicate that the presence and operation of marine-transportation facilities have not caused

long-term avoidance by belugas, the Kivalina combined spring and summer subsistence harvest declined about the time the facilities were constructed and have remained below preconstruction levels in most years since then. Other factors figuring into the decline of the beluga hunt could include long-term changes in ice conditions, beluga mass mortality reported in Siberian waters, and changes in beluga response to increased noise and activity (U.S. Army Corps of Engineers, 2005; Huntington, 1999).

4.4.1.15.5.9. Anticipated Level of Cumulative Effects from Economic, Employment, and Demographic Change. The potential public health effects from economic, employment, and demographic change were discussed in the potential effects discussion above.

Socioeconomic status is a powerfully associated with population health indicators, and with rates of individual diseases, including, for example, cardiovascular disease and cancer (Adler and Newman, 2002; Pamuk et al., 1998). The anticipated effects on economy and employment are discussed in Section 4.4.1.11.1. Overall, revenues from onshore oil and gas production—the major source of income for the NSB—is projected to decline in coming decades. OCS activities could partially offset this decrease, but are not expected to reverse it. Demographic changes, in terms of influx of direct and indirect workers, are shown in Tables 4.2.11-1 and 4.2.11-2.

The cumulative health effects associated with economic, employment, and demographic change would include the following: (1) revenues from oil and gas activities presently fund the public health, water, and sanitation services offered by the NSB (described in Section 3.4.3). To the extent that revenues from OCS activities augment NSB revenue sources, they would help prevent the curtailment of current services but would not be expected to provide additional revenue above current levels; (2) the influx of large number of nonresident workers from outside the area, particularly in the case of a shorebase located near a village, or the staging of activities from a village, could result in increased social stress and tension (described in Section 4.4.1.13), and this could exacerbate psychosocial health issues such as substance abuse, depression and anxiety, violence, and suicide; (3) the influx of workers associated with oil and gas activities has been associated with drug and alcohol problems in some studies, as discussed under the potential effects discussion above and has been reported by residents of Nuiqsut. The influx of large number of nonresident workers could reduce the efficacy of local prohibition ordinances, leading to higher rates of drug and alcohol abuse and injuries; (4) the influx of nonresident workers could create an economic strain on NSB systems that protect health, including water and sanitation infrastructure, police staffing, EMS personnel, schools, roads and runways, and potentially some others; (5) employment and income generally support health—improving overall health outcome indicators and the rates of many specific diseases. The role of OCS-related income would best be viewed as contributing to slowing the projected decline in revenues and employment related to oil and gas activities, as opposed to augmenting existing levels; and, (6) a large influx of workers from outside the region to or through NSB communities would create the risk of infectious disease transmission. This effect would be most prominent in cases where a major new facility such as a shorebase, or a new access route led to sustained changes in the flow of people from outside the region through a village. Alternative 1, the No Action Alternative, would not contribute to the cumulative effects on public health from economic, employment, and demographic change.

4.4.1.15.5.10. Anticipated Level of Cumulative Effects from Production Activities.

Anticipated cumulative effects from production activities on subsistence resources and practices were discussed in Sections 4.4.1.12.4.10 and 4.5.1.12.4.10 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from production activities on sociocultural systems were discussed in Sections 4.4.1.13.4.9 and 4.5.1.13.4.9 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from production activities were discussed in Section 4.4.1.15.2.10. These activities would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and

sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population. The potential effects from production activity are discussed in the potential effects discussion above.

Cumulative past and present actions related to effects from production activities on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7. Cumulative effects on sociocultural systems were previously discussed in Sections 4.4.1.13.7 and 4.5.1.13.7. These activities would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

The cumulative health effects from production activities would depend on: (1) disruptions to subsistence resources, harvests, and practices; (2) the influx of nonresident workers to and through communities; and, (3) the construction of new roads, pipelines, and facilities. Most of these effects have been discussed under potential effects discussions above. The assessment of cumulative effects on subsistence from production activity is limited by the absence of baseline data and consistent monitoring of past and present oil and gas production-related impacts (see Section 4.4.1.12.). Alternative I, the No Action Alternative, would not contribute to production activity.

4.4.1.15.5.11. Anticipated Level of Effects from Climate Change. Anticipated effects from climate change on subsistence resources and practices were discussed in Sections 4.4.1.12.4.11 and 4.5.1.12.4.11 for the Beaufort and Chukchi seas no-action alternatives. Anticipated effects from climate change on sociocultural systems were discussed in Sections 4.4.1.13.4.10 and 4.5.1.13.4.10 for the Beaufort and Chukchi seas no-action alternatives. Potential effects on EJ from climate change were discussed in Section 4.4.1.15.2.11. These actions would be expected to impact EJ to the extent they adversely impacted subsistence resources and practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat population.

Because potential climate change impacts on marine and terrestrial ecosystems in the Arctic would cause significant impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic and on Alaska's North Slope would be expected to experience disproportionate, high, adverse environmental and health effects. See Section 4.4.1.12.4.11 for a discussion of cumulative global climate change impacts on subsistence-harvest patterns. The potential effects on public health related to climate change were discussed in the potential effects discussion above.

Cumulative past and present actions related to effects from climate change on subsistence resources and practices were discussed in Sections 4.4.1.12.7 and 4.5.1.12.7 for the Beaufort and Chukchi seas no-action alternatives. Cumulative effects on sociocultural systems were discussed in Sections 4.4.1.13.7 and 4.5.1.13.7 for the Beaufort and Chukchi seas no-action alternatives. These actions would be expected to impact EJ to the extent they adversely impacted subsistence harvests and practices and sociocultural systems.

Because of rapid and long-term impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope communities would experience significant and long-term cultural stresses in addition to major impacts on population, employment, and local infrastructure. If subsistence livelihoods are disrupted, communities in the Arctic could face increased poverty, drug and alcohol abuse, and other social problems. As stated by Parson et al. (2001):

It is possible that projected climate change will overwhelm the available responses. It is also realistic to expect that some general assistance could be found to mitigate the losses of nutrition, health, and income from diminished subsistence resources, but such assistance would likely have little effect in mitigating the associated social and cultural impacts. (Langdon, 1995; Peterson and Johnson, 1995; National Assessment Synthesis Team, 2000; IPCC, 2001; Callaway et al., 1999; ARCUS, 1997; USDOJ, MMS, 2006a,b, 2007c)

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic significantly could affect subsistence harvests and uses if warming trends continue (NRC, 2003; ACIA, 2004). Every community in the Arctic potentially is affected by the anticipated climactic shift, and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of Kaktovik, Nuiqsut, Barrow, Atkasuk, Wainwright, Point Lay, and Point Hope. If the loss of permafrost, and conditions beneficial to the maintenance of permafrost, arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of freshwater, and availability of terrestrial mammals, marine mammals, waterfowl, and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC, 2003; ACIA, 2004; USDOJ, BLM, 2005; USDOJ, MMS, 2006b).

The cumulative effects of climate change on health are likely to be complex and cannot be estimated with certainty. Climate change is likely to influence the distribution and availability of subsistence resources, the stability of local housing and infrastructure, regional economy and demographics, and direct climate-related health effects. As stated by the U.S. Climate Change Science Program, Alaska communities will be particularly vulnerable to: (1) extreme precipitation, resulting in contaminated water and food supplies in areas with outdated water treatment plants; (2) wildfires resulting in degraded air quality, contributing to asthma and COPD; and (3) “fewer cold waves and higher minimum temperatures,” which could reduce cold-related injury (CCSP, 2008.) The emergence of new infectious diseases is highly likely as warmer conditions allow vectors not seen in the Arctic to begin to survive there; early evidence of such changes has already been reported with the emergence of *V. parahemolyticus* as a pathogen in Alaska in 2004 (CCSP, 2008). Ozone depletion—the result of pollution and warming—is increasing in the Arctic and may lead to increases in UV related problems such as skin cancers.

Many changes are already being observed. Thinner ice has made conditions more difficult for spring whaling crews to land successfully harvested whales; unpredictable ice conditions and late freeze-ups have made it more difficult and dangerous for hunters to harvest and travel in the early season on land. According to the IPCC, these changes are likely to accelerate in coming decades (IPCC, 2007).

One of the most serious EJ implications for climate change is that coastal communities and low-income communities will likely be disproportionately impacted. The remoteness and limited sources of income in NSB communities may limit their ability to adapt and respond to the major challenges posed by accelerated erosion and infrastructure problems that are already beginning to be seen in Alaska (ACIA, 2004). As these stresses accumulate, it will become more difficult for communities to respond to other challenges, such as more difficult subsistence-harvest conditions, creating the risk that health disparities will be exacerbated. Alternative I, the No Action Alternative, would not contribute to the cumulative effects from climate change.

4.4.1.15.6. Traditional Knowledge on Cumulative Effects. Traditional knowledge relating to cumulative effects on subsistence resources and practices was discussed in Section 4.4.1.15.6. Traditional knowledge relating to individual impact effects on sociocultural systems was discussed in Sections 4.4.1.13.9 and 4.4.1.13.5.

4.4.1.15.7. Direct and Indirect Effects Under Alternative 1.

Conclusion. There would be no direct or indirect EJ or public health impacts in the project area from Lease Sales 209 or 217 if the sales were not held.

4.4.1.15.8. Cumulative Effects Under Alternative 1.

The contribution of future MMS and other activities effects on subsistence resources and practices were discussed in Sections 4.4.1.12.7, and on sociocultural systems in Section 4.4.1.13.7. The same activities would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

In the Chukchi Sea, west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the DeLong Mountain Terminal. These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the Planning Area (USDOI, MMS, 2006a).

Summary. All the effects discussed above contain an EJ component. The central issue of effects on subsistence is used as a proxy or construct for this potential complex of EJ. Inevitably, “perceptions of risk” exist among local residents concerned about accidents or new development projects in general, and manifest in fears and concerns for stakeholder cultural rights and resources. Considering the importance of social networks that are maintained through subsistence cultural patterns, any type of disruption adds to cumulative change. The mere fact that many residents of the NSB engage in actively opposing offshore development cumulates social change.

Regional oil and gas activities are part of a petroleum economic sector that remains the major economic driver in the State of Alaska. Like most Alaskan natural resource extraction, petroleum-related activities occur primarily in rural, less populated parts of the State. The label “urban-rural divide” often is used locally to sum up the perceived differences between rural and urban Alaska on a wide range of measures, such as per capita income, quality of housing, level of education, the availability and quality of services, and disparities in health indicators. These differences raise EJ issues, because rural parts of the State also are predominantly Native Alaskan. Moreover, when oil and gas activities occur, their direct effects would be most evident in coastal areas where many rural Native settlements are located.

The importance of subsistence activities to household economy, cultural identity, and health has been discussed in Section 4.4.1.12. Potential direct and indirect effects also have been discussed, such as harvest disruptions due to noise or increased competition due to access roads. Major cumulative effects on sociocultural systems and subsistence-resource uses are possible, as described in the cumulative effects discussions for subsistence and sociocultural systems (Sections 4.4.1.12.7, 4.5.1.12.7, 4.4.1.13.7, and 4.5.1.13.7, respectively).

Oil and gas activities could contribute to cumulative effects in several ways. These activities have the potential to disrupt marine mammal harvests (primarily bowhead whales, walrus, seals, and beluga whales) by diverting marine migrations or by causing other behavioral changes, such as increased wariness. The greater the degree of development, the more probable and more pronounced such effects

are likely to be. However, mitigation measures directed at exploration and development activities should help minimize effects to subsistence resources and practices.

Cumulative effects on Alaskan Inupiat Natives could occur because of their reliance on subsistence foods, and impacts from noise and vessel traffic from past, present, and foreseeable activities in the Chukchi and Beaufort seas could affect subsistence resources and harvest practices. The Executive Order on EJ and this EIS define major effects on EJ as disproportionate, high, adverse impacts to low-income and minority populations. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of Beaufort and Chukchi seas coastal communities in the NSB and NWAB, the area potentially most affected by cumulative exploration, development, and production activities.

Potential cumulative effects from (1) increased seismic activity; (2) aircraft and vessel noise; (3) traffic disturbance; (4) construction disturbance from activities associated with ice roads, landfalls, shore bases, production facilities, pipelines, and gravel mining; (5) supply efforts; (6) oil spills; and, (7) human health impacts on subsistence resources and practices and sociocultural patterns would focus on the Inupiat communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope and subsistence communities on the Russian Chukchi Sea coast. Nuiqsut potentially would be the most affected community, because it is within an expanding area of oil exploration and development onshore. Potential major cumulative impacts to subsistence resources and harvests and sociocultural systems could result in adverse EJ impacts. Onshore development would include Alpine, Alpine Satellite, Northeast and Northwest NPR-A, the Red Dog Mine, and the DeLong Port Facility expansion; nearshore development includes the Ooguruk and Nikaichug field developments. Offshore projects include Northstar, the proposed Liberty project, increased seismic-exploration activity, potential drilling operations off Kaktovik, and Canadian drilling off the McKenzie River Delta (USDOJ, MMS, 2007d).

Avoidance planning, stipulations and required mitigation, conflict avoidance measures under IHA requirements as defined by NMFS and FWS, and AMMPs required by MMS collectively would serve to mitigate seismic and noise disturbance effects on EJ. Mitigation measures likely would incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and Tribal and local governments. With required mitigation measures in place, major impacts to subsistence resources and hunts from seismic activity and noise and disturbance would not be expected to occur, thereby avoiding major impacts on sociocultural systems and disproportionate, high, adverse impacts on low-income and minority populations in the region—major EJ impacts.

The Arctic Multiple-Sale OSRA assessed the effects of an accidental spill of 1,500 bbl or 4,600 bbl on subsistence, concluding that if a spill occurred, oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a spill could affect bird hunting, sealing, the walrus hunt, and whaling, as well as the netting of fish in the ocean. Potential tainting and contamination effects on bowhead and beluga whales and other marine mammals, including walruses and polar bears, would be considered major.

Environmental justice effects would derive from potential noise, disturbance, and oil-spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. The only substantial source of potential EJ-related effects to coastal subsistence-oriented communities on the Alaskan and Russian Chukchi Sea coastline would occur in the event of a large oil spill, which could affect subsistence resources. A large oil spill could contaminate essential whaling areas and marine mammal harvest areas, and major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. In the event of a large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share

bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. Oil-spill contamination of subsistence foods is the main concern regarding potential effects on Native health. Such effects would represent disproportionate, high, adverse effects to Alaskan Natives in Beaufort and Chukchi seas coastal communities and would constitute major EJ impacts. Effects are expected to be mitigated substantially, although not eliminated. Furthermore, potential long-term impacts on human health from contaminants in subsistence foods, ongoing and increasing social pathologies due to increasing development activities both on- and offshore, and climate change effects on subsistence resources and practices would be expected to exacerbate overall potential effects on low-income, minority populations.

Increases in population growth and employment could cause long-term disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence product and consumption, (2) extended families, and (3) informally derived systems of respect and authority (mainly respect of elders and other leaders in the community). Cumulative effects on social organization could include decreasing importance of the family; cooperation, sharing and subsistence as a livelihood; and increased individualism, wage labor and entrepreneurship. Long-term effects on subsistence-harvest patterns also could be expected.

At the same time, revenues from NSB taxation on oil development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. Nevertheless, we may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, and suicide. Because Nuiqsut is relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community – a major effect; however, overall effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional subsistence practices. Such chronic disruption could affect subsistence-task groups and displace sharing networks, but it would not tend to displace subsistence as a cultural value. This same potential exists for the other communities in the Beaufort and Chukchi seas regions as areawide leasing, exploration, and development proceed on- and offshore.

Onshore, long-term activities associated with NPR-A leasing and Alpine development as contemplated in the cumulative case could cause long-term displacement and/or functional loss of habitat to the Central Arctic, Teshekpuk Lake, and Western Arctic caribou herds over the life of these projects. This could result in a major impact on access to, and perhaps the availability of, this important subsistence resource. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development were to reduce the availability of resources or alter their distribution patterns (USDOI, BLM, 2004).

In addition to direct and indirect loss of habitat that can affect subsistence species, noise and other disturbance associated with oil and gas development would divert, deflect, and disturb subsistence species, potentially having population-level effects that would accumulate. Onshore oil and gas development also could affect subsistence harvest by causing subsistence hunters to avoid certain areas because of concerns about firearm safety, and perhaps for aesthetic reasons. Although the North Slope still has a huge amount of area that is relatively undisturbed, the general subsistence-hunting environment continues to change in response to increased development. During the past several decades, populations of caribou, bowhead whales, and other wildlife and fish generally have increased, to the benefit of subsistence hunters, despite habitat, disturbance, and other effects that have accumulated. However, there is no certainty that these trends would continue into the future, especially as the effects of global climate change on the arctic environment become more pronounced (USDOI, BLM, 2005).

North Slope Inupiat have repeatedly spoken out against planned and ongoing offshore oil and gas exploration and development, due to the importance of bowhead whaling and sea mammal hunting to their cultural identity and well-being. Should offshore activity result in changes in the migration paths of whales, and an associated decrease in the ability for whalers to harvest them, this activity would have a substantial negative effect on this recognized minority population (USDOJ, BLM, 2005).

Transportation facilities and activities also would contribute to cumulative effects to subsistence resources and, consequently, to the Native population. A new, permanent road connection from TAPS to Nuiqsut and the NPR-A also would facilitate petroleum development and could provide an additional travel route for the public to the North Slope. This could encourage more hunters and other visitors to travel to the planning area, increasing the potential for conflicts between subsistence users and other users of fish and wildlife resources, as well as the potential for additional health impacts (USDOJ, BLM, 2005).

It is acknowledged that cumulative sociocultural impacts have occurred on the North Slope, and that Inupiat culture has undergone a noticeable change. The influx of money from wage employment has added benefits and raised the standard of living but also has given rise to an array of social pathologies, including increased alcoholism (see the Human Health Effects discussion above). Onshore, expanded oil and gas development on the North Slope and in Northwest Alaska on both Federal and State leases would expand the extent of disturbance effects on subsistence resources and harvest patterns. While each individual project likely would be a small incremental increase, the cumulative effect of such projects eventually would become more and more restrictive to the subsistence lifestyle. In addition to potentially diverting, deflecting, or disturbing subsistence species, oil and gas development could affect subsistence harvests by causing subsistence hunters to avoid certain areas because of concerns about firearm safety and perhaps for aesthetic reasons. The North Slope still has vast undisturbed areas, yet the general subsistence hunting environment continues to change in response to increased development (USDOJ, BLM, 2006).

Because potential climate change impacts on marine and terrestrial ecosystems in the Arctic would cause major impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic would be expected to experience disproportionate, high, adverse environmental and health effects. See Sections 4.4.1.12.4.11 and 4.4.1.13.4.10 for a discussion on climate change effects.

Conclusion. Potential major cumulative impacts to subsistence resources and harvests and sociocultural systems would indicate consequent major cumulative environmental justice impacts—disproportionate, high, adverse environmental and health effects on low-income, minority populations in the region. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of Beaufort and Chukchi seas coastal communities in the NSB and NWAB, the region potentially most affected by past, present, and reasonably foreseeable projects on- and offshore in the Chukchi and Beaufort coasts.

Environmental Justice effects on Inupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices, sociocultural systems, and human health. Potential effects would focus on the Inupiat communities of Kaktovik, Nuiqsut, Barrow, Atkasuk, Wainwright, Point Lay, Point Hope, and subsistence communities on the Russian Arctic Chukchi Sea coast. Offshore, major effects are not expected from routine activities and operations; however, if a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

Onshore, cumulative development, especially from potential road development within NPR-A and Alpine satellite field expansion, could impact subsistence resources and harvest practices. Subsistence resources,

particularly caribou, could experience long-term disturbance and displacement effects, as well as functional loss of habitat and potential population reductions, causing subsistence hunters to alter traditional harvest practices by having to travel to unfamiliar areas. If this occurred, long-term displacement of ongoing social systems would be expected. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources would be altered, and disproportionate, high, adverse effects would be expected for the Inupiat communities of Nuiqsut, Barrow, Atkasuk, Wainwright, Point Lay, and possibly Point Hope.

Potential impacts on human health from contaminants in subsistence foods; changes in health status; and long-term climate change effects on marine and terrestrial ecosystems in the Arctic—affecting subsistence resources, traditional culture, and community infrastructure of subsistence-based indigenous communities in the NSB and NWAB—would be an expected and additive contribution to cumulative EJ impacts. Potential disproportionate, high, adverse effects on low-income, minority populations in the region are expected to be mitigated substantially but not eliminated.

4.4.2. Alternative 2, Beaufort Sea Proposed Action for Sales 209 and 217.

Beaufort Sea Alternative 2, the Proposed Action for Sales 209 and 217, would offer for lease the entire program area as scheduled in the 2007-2012 5-Year Program. The program area encompasses 6,123 whole or partial blocks that cover approximately 33,194,467 acres (about 13,426,469 hectares). This area, minus any blocks currently leased at the time of the sale, would be offered in the proposed sales.

4.4.2.1. Water Quality.

Summary. The activities associated with petroleum exploitation resulting from proposed Sales 209 and/or 217 would be unlikely to have any substantial effects on water quality. A large oil spill $\geq 1,000$ bbl (42,000 gal) is unlikely to occur. However, if a large spill were to occur, it would not cause significant long-term degradation of the quality of Beaufort Sea water. Concentrations of hydrocarbons in water would be less than the acute criterion within 3 days of spillage, and concentrations above the chronic criterion likely would persist <30 days.

Small oil spills would not have degradational effects on the overall water quality of the Beaufort Sea. The small spills would degrade the water quality locally for a relatively short period of time, although frequent small spills in an area could result in local, chronic contamination. The concentrations of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits. Also, the total organic compounds in the sediments of the Beaufort Sea are present in concentrations that indicate an unpolluted environment, with no significant indication of an anthropogenic increase since start of oil development in the Beaufort (Naidu et al., 2001).

Drilling muds and cuttings and other discharges associated with exploration drilling would have little effect on the overall water quality of the Beaufort Sea. Within a distance of between 100 and 200 m (100-200 yd) from the discharge point, the turbidity caused by suspended-particulate matter in the discharged muds and cuttings would dilute to levels that are less than the chronic criteria (100-1,000 parts per million [ppm]) and within the range associated with the variability of naturally occurring suspended-particulate matter concentrations. Mixing in the water column would reduce the toxicity of the drilling muds, which are already required by the EPA to be practically nontoxic (EPA, 2006b), to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges would likely be relatively small and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters. The potential effects in any of the areas where there are permitted discharges would be temporary.

Produced waters from a production platform likely would be injected into underlying formations. Even if discharged, produced waters would not be expected to degrade the quality of Beaufort Sea water. The other routine discharges associated with oil production would not cause any substantial degradation of Beaufort Sea water quality. Discharges associated with production activities will require an individual NPDES permit.

Overall, any effects on water quality from the proposed lease sales would be temporary due to dilution. The level of impact on water quality would be minor locally and negligible regionally, due to the requirements of EPA and State of Alaska water quality criteria. Proposed mitigation measures would not reduce effects further.

4.4.2.1.1. Direct and Indirect Effects Under Alternative 2. This section assesses the possible/probable impacts associated with oil and gas exploration activities in the Beaufort Sea. Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in

respect to its suitability for a particular purpose. To develop the assessment of impacts to water quality, we considered the assessment scenario (Section 2.4), the impacts associated with those activities described within the scenario and historical trends in the regulatory compliance and industry. Oil and gas drilling generates a wide range of waste materials related to the drilling process, equipment operations and maintenance, and personnel housing. The proportions and amounts of discharged wastes can change considerably during the lifecycle of postlease exploration, development, and operations activities.

Water Quality Criteria. The EPA's Ocean Discharge Criteria (40 CFR § 125) sets forth specific determinations of unreasonable degradation that must be made prior to EPA approving permit actions. Unreasonable degradation of the marine environment is defined (40 CFR § 125.121[e]) as follows:

- Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities;
- threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or
- loss of aesthetic, recreational, scientific, or economic values, which are unreasonable in relation to the benefit derived from the discharge.

Determination of impacts to water quality resulting from marine discharges is based on consideration of the following 10 criteria (40 CFR § 125.122):

- The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged.
- The potential transport of such pollutants by biological, physical, or chemical processes.
- The composition and vulnerability of the biological communities that may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the ESA, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain.
- The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the lifecycle of an organism.
- The existence of special aquatic sites including, but not limited to, marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs.
- The potential impacts on human health through direct and indirect pathways.
- Existing or potential recreational and commercial fishing, including finfishing and shellfishing.
- Any applicable requirements of an approved Coastal Zone Management Plan.
- Such other factors relating to the effects of the discharge as may be appropriate.
- Marine water quality criteria developed pursuant to Section 304(a)(1) (33 U.S.C. § 1342) of the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) of 1972.

Federally promulgated water quality standards regarding toxic substances, including human-health criteria and aquatic-life criteria, are found at 40 CFR § 131. The State of Alaska, Department of Environmental Conservation (ADEC, 2008) water quality criterion states:

An effluent discharged to a water may not impart chronic toxicity to aquatic organisms, expressed as 1.0 chronic toxic unit, at the point of discharge, or if the department authorizes a mixing zone in a permit, approval, or certification, at or beyond the mixing zone boundary, based on the minimum effluent dilution achieved in the mixing zone. If the department determines that an effluent has reasonable potential to cause or contribute to exceedance of the whole effluent

toxicity limit, the department will require whole effluent toxicity testing as a condition of a permit, approval, or certification.

A “mixing zone” is the area adjacent to a discharge or activity in the water where receiving water may not meet all the water quality standards or criteria; wastes and water are given an area to mix so that the water quality standards or criteria are met at the mixing-zone boundaries. In determining whether to authorize a mixing zone, the ADEC (2008) will consider:

- the characteristics of the receiving water, including biological, chemical, and physical characteristics such as volume, flow rate, and flushing and mixing characteristics;
- the characteristics of the effluent, including volume, flow rate, dispersion, and quality after treatment;
- the effects, if any, including cumulative effects of multiple discharges and diffuse, nonpoint source inputs, that the discharge will have on the uses of the receiving water;
- any additional measures that would mitigate potential adverse effects to the aquatic resources present; and
- any other factors the department finds must be considered to determine whether a mixing zone will comply with this section.

4.4.2.1.1.1. Effects from Exploration and Development. The principal method for controlling discharges is through Section 402 (33 U.S.C. § 1342) of the Clean Water Act, which establishes a National Pollutant Discharge Elimination System (NPDES) (Laws, 1987). The general NPDES permit AKG280000 (EPA, 2006b) for the offshore areas of Alaska located in the Beaufort Sea, Chukchi Sea, Hope Basin, and Norton Basin authorizes discharges from oil and gas exploration facilities. This permit does not apply to development and production facilities, which require individual permits.

The following exploratory discharges are permitted under the Arctic general permit: drilling fluids and drilling cuttings; deck drainage; sanitary wastes; domestic wastes; desalination unit wastes; blowout preventer fluid; boiler blowdown; fire control system test water; noncontact cooling water; uncontaminated ballast water; bilge water; excess cement slurry; mud, cuttings and cement at seafloor; and test fluids. The Arctic general permit restricts the seasons of operation, discharge depths and areas of operation, and has monitoring requirements and other conditions.

Drilling Muds and Cuttings. Drilling muds are mixtures of water and natural and manmade additives that are pumped downhole to (1) cool the rapidly rotating drill bit, (2) lubricate the drill pipe as it turns, (3) carry rock cuttings to the surface, and (4) provide well control and spill prevention. Different properties may be required of the drilling fluid, depending on the drilling conditions. For example, a higher density fluid may be needed in high-pressure zones, and a more temperature-resistant fluid may be desired in high-temperature conditions. Drilling muds and cuttings are the most important and voluminous discharge during exploration drilling.

The discharge rate of drilling fluids (muds) and cuttings during well-drilling operations is quite variable. The volume of rock cuttings produced from drilling primarily is a function of the depth of the well and the diameter of the wellbore. The Arctic general NPDES permit AKG280000 (EPA, 2006b) limits the flow of drilling fluids and drilling cuttings to the following:

- 1,000 bbl (42,000 gal) per hour in water depth >40 m (131 feet),
- 750 bbl (31,500 gal) per hour in water depth between 20 and 40 m (66-131 ft),
- 500 bbl (21,000 gal) per hour in water depths between 5 and 20 m (16-66 ft).

Drilling muds and cuttings discharged into the Beaufort Sea would increase the turbidity of the water column and the rate of accumulation of particulate matter on the seafloor near the drilling unit. The EPA

and the ADEC water quality criteria for turbidity specific to aquatic life both specify that increased turbidity should not reduce the depth of the compensation point for photosynthetic activity by more than 10%. In addition, the Alaska criteria state that increased turbidity “may not reduce the maximum secchi disk depth by more than 10%.”

The discharge of drilling muds at the surface ensures dispersion and limits the duration and amount of exposure to organisms (NRC, 1983). When released into the water column, the drilling mud and cutting discharges tend to separate into upper and lower plumes (Menzie, 1982). The upper plume contains the solids separated from the material of the lower plume and kept in suspension by turbulence. Most of the solids in the discharge, more than 90%, descend rapidly (within 1 hour) to the seafloor in the lower plume. The heaviest materials (for example, barite particles and cuttings) accumulate closest to the discharge point, and the lighter mud components settle farther away. Small particles of drilling mud—up to several centimeters in diameter—also may settle to the seafloor immediately following a discharge but would disperse within a day (NRC, 1983).

Typical bulk constituents of drilling muds are water, barite, bentonite (a clay mineral), lignosulfonate, and lignite. In the drilling muds, the amount of barite would be about 75% of dry mud weight, bentonite about 2%, and lignite about 1.4%, with no other constituent over a fraction of a percent. These constituents are generally nontoxic to marine organisms at the dilutions reached shortly after discharge (NRC, 1983). Barium discharged in the drilling mud may persist in the marine sediments in deeper waters, however, and the concentrations may be more than 100 times greater than the concentrations that occur naturally in marine sediments. Natural concentrations of barium in Beaufort Sea coastal sediments range from 185-745 ppm (Crecelius et al., 1991). The barium in drilling mud is in the form of barite (barium sulfate). Barite has a low solubility and relatively high specific gravity, making it useful as a material to add weight to a drilling mud.

The current NPDES permit for the Arctic, AKG280000 (EPA, 2006b), allows discharge of exploration muds with only negligible toxicity as measured by 96-hour lethal concentration for 50% of test organisms (LC_{50}) tests. Toxicity is the inverse of the LC_{50} ; as the LC_{50} value increases, the toxicity associated with the substance decreases. For example, a substance with an LC_{50} of 1 million ppm is less toxic than a substance with an LC_{50} of 3,000 ppm. The classification of relative toxicity of chemicals to marine organisms proposed by the IMCO/FAO/UNESCO/WHO, reported in Neff (1991), provides a means of qualitatively assessing relative toxicities. Concentrations <1 ppm are classified as very toxic; 1-100 ppm are toxic; 100-1,000 ppm are moderately toxic; 1,000-10,000 ppm are slightly toxic; and >10,000 ppm are practically nontoxic. The current permit requires $LC_{50} > 30,000$ ppm in discharged muds (concentration at which half the test organisms die within 4 days) and discharges are prohibited in open water <5 m (16 ft) deep. Discharges are not allowed shoreward of the 20-m (66-ft) isobath in broken-ice conditions unless prediluted to a 9:1 ratio of seawater to drilling fluids and cuttings. Discharges are also prohibited below stable ice. The EPA estimates that these restrictions should ensure protection of water quality and human health.

The exploration and development scenarios described in Section 2.4 presuppose that 80% of the drilling mud would be reconditioned and reused. The total discharges from all estimated exploration wells are given in Table B-2. The discharge of exploratory drilling muds is expected to have minor local effects and negligible regional effects. Treatment and disposal of waste products from production wells (drilling muds, rock cuttings, and produced water) in the subsurface through injection wells is anticipated. Hence, production discharge is not anticipated.

Other Discharges.

Deck Drainage. Deck drainage refers to any waste resulting from platform washing; deck washing; spillage; rainwater; and runoff from curbs, gutters, and drains, including drip pans and wash areas. This also could include pollutants, such as detergents used in platform and equipment washing, oil, grease, and drilling fluids spilled during normal operations.

In addition to oil, various other chemicals used in drilling operations may be present in deck drainages. The chemicals may include drilling fluids, ethylene glycol, lubricants, fuels, biocides, surfactants, detergents, corrosion inhibitors, cleaners, solvents, paint cleaners, bleach, dispersants, coagulants, and any other chemical used in the daily operations of the facility (Kramme, 1985). A typical facility is equipped with drip pans and gutters to collect deck and drilling-flow drainage. The drainage is collected in a sump where the water and oil are separated by a gravity separation process. Oil in the sump tank is recovered and transferred to shore via pipeline or reinjected to the formation. The water from the sump is discharged to the ocean via a skim pile.

Deck-drainage discharges are not continuous and they vary considerably in volume. At times of platform washdowns, the discharges are of relatively low volume and are anticipated. During rainfall, very large volumes of deck drainage may be discharged in a very short time period. Deck drainage is a concern particularly in areas with high precipitation; however, the low arctic temperatures prevent high volumes of deck drainage due to the prolonged winter months, and precipitation drainage is expected to occur only during the open-water (summer) months.

Sanitary and Domestic Wastes. While some platforms discharge sanitary and domestic wastes separately, many combine these waste streams prior to discharge. Sanitary waste is human body waste discharged from toilets and urinals. It consists of secondary treated chlorinated effluent. Domestic waste (gray water) refers to materials discharged from sinks, showers, laundries, safety showers, eyewash stations, and galleys. Gray water can include kitchen solids, detergents, cleansers, oil, and grease. Domestic waste also includes solid materials such as paper and cardboard, which must be disposed of properly.

The concentration of sanitary wastes varies widely with time, occupancy, platform characteristics, and operational situation. Pollutants of concern in untreated sanitary waste include biological oxygen demand (BOD), total suspended solids, fecal coliform, and residual chlorine. Average monthly limits of these pollutants permitted for discharge under the Arctic general NPDES permit AKG280000 are 30 milligrams per liter (mg/L) (30 ppm), 30 mg/L (30 ppm), 100 colonies/100 milliliters (mL) and 0.5 mg/L (0.5 ppm), respectively (EPA, 2006b).

There are two alternatives for handling of sanitary wastes from offshore facilities. The wastes can be treated at the offshore location, or they can be retained and transported to shore facilities for treatment. Because of the remote areas of operation and storage limitations, most offshore facilities usually treat and discharge sanitary wastes at the source. The treatment systems presently in use may be categorized as physical/chemical or biological.

These discharges are expected to represent only small pollutant loadings when properly designed and functioning equipment is used. Dispersion in the receiving waters would further decrease the concentration of any contaminants.

Produced Waters. Just as for muds and cuttings from production wells, the discharge of produced waters is not anticipated. Instead, produced waters are expected to be injected back into underlying

formations, as described in Section 2.4. Historically, produced waters constituted the largest source of substances discharged into the marine environment. These waters are part of the oil/gas/water mixture produced from the wells and contain (1) a variety of substances dissolved from the geologic formations through which they migrated and in which they became trapped and (2) the soluble fractions of any hydrocarbons they might have encountered. The mixtures produced from the wells may also contain substances added to the waters injected into the producing formations and may contain chemicals added during the oil/gas/water separation process (Veil et al., 2004).

Additives to the injection waters might include flocculants, oxygen scavengers, biocides, cleansers, and corrosion inhibitors; the types and amounts of additives used would depend on the reservoir and production conditions. A variety of chemicals may also be added to the oil/water separation process to aid in separating the oil and gas from the water. The most commonly used types of compounds added to the production stream include scale inhibitors, emulsion breakers, biocides, and corrosion inhibitors. These chemicals can pose concerns related to aquatic toxicity. However, these substances may undergo reactions that reduce their toxicities before they are discharged or injected. In addition, corrosion inhibitors can form more stable emulsions, thus making oil/water separation less efficient (Veil et al., 2004).

Over the life of a field, the volume of formation waters produced may be equal to 20-150% of the oil-output volume (Collins et al., 1983). As oil is pumped from a field, the ratio of water to oil being produced increases. Prudhoe Bay oil production began in 1969 and reached full production in 1977 with the completion of the TAPS. The ratio of water to oil for Prudhoe Bay in 1978 was <0.003. In 2004, the ratio was 6.18 and the ratio of total water produced to total oil produced for Prudhoe Bay is 0.68 after 36 years of production (State of Alaska, Oil and Gas Conservation Commission, 2005).

Characteristics of the Produced Waters. The toxicity of produced waters is mainly caused by hydrocarbons (Brown et al., 1992). The treatment process removes suspended oil particles from the waters, but the effluent contains hydrocarbons that are dissolved or held in colloidal suspension. The treated produced waters contain the more soluble, low-molecular weight (LMW) saturated and aromatic hydrocarbons. On this basis, the analysis of the effects of produced-water discharges focuses on nonvolatile hydrocarbons (called oil and grease by the EPA) and total aromatic hydrocarbons, two of the characteristics that can be related to water quality criteria. Other characteristics of the produced waters discussed in this section are based on those features that also can be related to water quality criteria or compared to existing parameters in the water column. These characteristics include toxicity, pH, salinity, biological oxygen demand, and metal concentrations.

Water Quality Criteria for Hydrocarbons. The State of Alaska water quality criteria for marine water uses (ADEC, 2008), specific to the growth and propagation of fish, shellfish, aquatic life, and wildlife, state that total hydrocarbons in the water column shall not exceed 15 µg/L (15 parts per billion [ppb]). In addition, the State of Alaska water quality criteria (ADEC, 2008) state that total aromatic hydrocarbons in the water column shall not exceed 10 µg/L (10 ppb). These limits originally derive as a hundredfold safety factor, 0.01 of the lowest measured continuous flow 96-hour LC₅₀, for life stages of species identified by the ADEC as the most sensitive, biologically important species in a particular location (ADEC, 1989).

The water quality criteria are intended to represent the water-soluble or water-accommodated fraction of crude or refined oil similar to that used in many laboratory acute and chronic toxicity tests (Neff and Douglas, 1994). The water-soluble fraction includes primarily LMW aromatic hydrocarbons, such as benzene, toluene, ethylbenzene, and total xylenes, with lesser amounts of naphthalene, alkylnaphthalenes, phenanthrene, and light aliphatic hydrocarbons.

The EPA's water quality criteria for marine waters (EPA, 1986, 2006b) do not include the total hydrocarbon or total aromatic categories found in the State criteria. Instead, the EPA's criteria include (1) criteria for oil and grease and (2) both acute and chronic criteria for the individual hydrocarbons. Under the current general NPDES Arctic discharge permit (EPA, 2006b), the monthly average discharge limitation for nonvolatile hydrocarbons (oil and grease) in authorized test fluid discharges is 29 mg/L (29 ppm). The maximum daily discharge limitation is 42 mg/L (42 ppm). The EPA's *Effluent Guidelines and Standards* for offshore oil and gas production facilities can be found at 40 CFR § 435.

Information based on toxicity tests is used to establish criteria that may be considered a measure of water quality. Chronic toxicity tests measure the sublethal effects of substances on such factors as growth, development, reproduction, or behavior. Acute toxicity tests determine the concentration of a substance that causes the mortality (i.e., lethal effects) of some fraction of the test population (for example, half of the population in the LC₅₀ test) during a certain period of time (usually 4 days [96 hours]). Most of the information on toxicity is based on the results of acute toxicity tests and, where there are no chronic toxicity tests, an application or safety factor is used to extrapolate to probable sublethal effects. For most toxicants, the chronic toxicity is estimated to 0.01 to 0.001 of the acute toxicity. For this analysis, the acute criterion is assumed to be 100 times greater than the chronic criterion, which results in the chronic criterion being 0.01 of the acute criterion.

Nonvolatile Hydrocarbons (oil and grease) and Total Aromatic Hydrocarbons. Nonvolatile hydrocarbons (oil and grease) consist of a variety of organic substances including hydrocarbons, fats, oils, and waxes. The EPA's gravimetric method for determining oil and grease measures certain classes of carbon compounds such as fatty acids, phenols, and related compounds that do not appreciably contribute to the toxicity of produced waters (Brown et al., 1992). The fate of any petroleum hydrocarbons released into the water column along with the produced waters is expected to be similar to the fate of spilled oil in seawater. The discharged substances are affected by chemical and biochemical degradation processes, evaporation, and dissolution and dispersion.

Effects of Mixing. Although produced waters are expected to be reinjected rather than discharged, the effects on water quality, if such discharge were permitted, can be estimated. Produced waters discharged into the mixing zone would likely have concentrations of nonvolatile hydrocarbons averaging 29 ppm or less and total aromatic hydrocarbons with an approximate range of 8-13 ppm. Mixing of the produced waters with the receiving waters reduces the concentrations of the substances in the discharges.

The nonvolatile hydrocarbons (oil and grease) in the produced waters from an oil-production platform would likely be diluted a thousandfold within several hundred meters if discharged. At a 1,000:1 dilution, the concentrations of nonvolatile hydrocarbons would reduce from 29 ppm to 29 ppb within several hundred meters of the platform. The concentrations of total aromatic hydrocarbons might range from 8-13 ppm near the platform to 8-13 ppb farther away. These concentrations at several hundred meters distance are well below the acute criteria of 1,500 ppb for the nonvolatile hydrocarbons and 1,000 ppb for the total aromatic hydrocarbons that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 ppb for the nonvolatile hydrocarbons and 10 ppb for the total aromatic hydrocarbons. At some point within this several-hundred-meter distance, acute and chronic criteria would be exceeded. In OCS waters, mixing zones are limited to a 100-m (328-ft) radius. This limitation does not apply to State waters, where mixing zones can be expanded as necessary to ensure that these criteria are not exceeded outside the mixing zone.

Note, however, that mixing is a continuous process, and the dilution rate would depend on the energy of the local receiving environment as derived from the local currents and waves. Evaporation would remove some of the aromatic hydrocarbons from the water column; Jordan and Payne (1980) note that

evaporation may remove the majority of the more volatile compounds within 24-28 hours after an oil spill. In addition, biodegradation processes act to continuously change the hydrocarbon compounds in the waters.

Some Other Characteristics of Produced Waters. Other characteristics of produced waters include trace metals, pH, salinity, and biological oxygen demand. The pH of surface seawater generally is about 8.2 (Millero and Sohn, 1991). The general NPDES permit discharge limit ranges from 6-9. The BOD and metal amounts produced from the production platform can be compared with the amounts found in other point sources. Produced waters are a minor potential source of these contaminants. Sampling has not shown a significant increase in trace metals or hydrocarbons in Beaufort Sea sediments between 1977 and 1997 (Naidu et al., 2001). Naturally Occurring Radioactive Materials (NORM) should be expected to occur in low concentrations in produced waters. The NORM is best monitored indirectly, taking advantage of natural biological or chemical concentration mechanisms such as shell formation (Farrington et al, 1983; Goldberg et al., 1983).

4.4.2.1.1.2. Effects from Construction Activities. Sediment resuspension and bottom disturbances are likely to occur as a result of siting platforms, creating artificial islands, and trenching and burying subsea pipelines. The amount of disturbance associated with platform siting, anchor setting, and drilling would be minimal and restricted to the area immediately adjacent to the activity. Sediment levels likely would be reduced to background levels within several hundred meters downcurrent. The size, duration, and amount of turbidity depend on the grain-size composition of the discharge, the rate and duration of the discharge, the turbulence in the water column, and the current regime.

Experiences with actual dredging or dumping operations offshore of Alaska and in other U.S. waters show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance (1-3 km [0.54-1.62 nautical miles {nmi}]) downcurrent from the discharge. In dredging operations associated with artificial-island construction and harbor improvements in the mostly sandy sediments of the Canadian Beaufort Sea, the turbidity plumes tended to disappear shortly after operations ceased. Plumes generally extended from a few hundred meters to a few kilometers (Pessah, 1982).

Prior to any discharge of dredge or fill material into U.S. waters, permits and approval from State and Federal regulatory agencies would be required; with associated followup project-specific environmental assessment process and documentation as required. Effects on water quality from dredging (and dumping) are expected to be local and short term. Effects on local water quality are expected to be minor, while regional effects are expected to be negligible.

4.4.2.1.1.3. Effects from Oil Spills.

Fate of Petroleum in Seawater. Petroleum released into seawater is exposed to a variety of physical, chemical, and microbiological processes that operate interdependently and simultaneously with each other to degrade and eventually remove it from the water column (Karrick, 1977). The fate of petroleum in seawater is discussed in Appendix A.1. During the degradation process, some of the various constituents of the spilled oil would spread over the sea surface, evaporate into the atmosphere, disperse and dissolve into the water column, form water-in-oil emulsions, wash onto beaches and sink to the seafloor, and change by chemical and microbiological processes.

Effects from Oil Spills. Only small, accidental oil spills would likely occur in the sale area, if oil production occurs as a result of Sale 209 or 217 (Appendix A.1). Small oil spills are defined as spills <1,000 bbl offshore or spills <500 bbl onshore. For spills <500 bbl, the average spill size of crude oil is 3 bbl (126 gal), and the average spill of refined oil is 0.7 bbl (29 gal). During the 20-year oil production

period, an estimated 89 crude oil spills and 220 refined oil spills <500 bbl could occur, for a total of approximately 421 bbl.

The data indicate that for Alternative 2, a spill of 1,000 bbl or greater is unlikely to occur. However, for purposes of analysis, we do evaluate the potential effects of such a spill.

Federal standards are set at 0.01 of the applicable LC₅₀; no absolute Federal concentration standard exists for hydrocarbons (EPA, 1986). “Applicable” in this case refers to life stages of species identified as the most sensitive, biologically important species in a particular location. Applicable ambient-water quality standards for marine waters of the State of Alaska are (1) total aqueous hydrocarbons in the water column may not exceed 15 µg/L (15 ppb); (2) total aromatic hydrocarbons in the water column may not exceed 10 µg/L (10 ppb) and (3) surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration (ADEC, 2008). The State of Alaska criterion of a maximum of 15 ppb of total aqueous hydrocarbons in marine waters—about 15 times background concentrations—provides the readiest comparison and is used in this discussion of water quality. This analysis considers 15 ppb to be a chronic criterion and 1,500 ppb—a hundredfold higher level—to be an acute criterion.

Very large spills generally result in peak dissolved-hydrocarbon concentrations that are only locally and marginally at toxic levels—parts per million or more. The concentration of oil from the *Argo Merchant* spill (0.18 million barrels [Mmmb], 7.56 million gal) ranged relatively low, from 90-170 ppb at the surface and up to 340 ppb in the water column (NRC, 1985). At several of the sampling stations, the concentrations were uniform to a water depth of 20 m. Concentrations of oil in water from the *Amoco Cadiz* spill (1.64 Mmmb) ranged from 2-200 ppb in the nearshore area to 30-500 ppb in the estuaries (Gundlach et al., 1983). Volatile liquid hydrocarbons in the Ixtoc spill (3.33 Mmmb) decreased from 400 ppb near the blowout to 60 ppb at a 10-km (5.4-nmi) distance and to 4 ppb at a 19-km distance (NRC, 1985). Similar rapid decreases also were found for specific toxic compounds such as benzene and toluene. Concentrations of volatile-liquid hydrocarbons, present mostly as oil-in-water emulsion, within 19 km of the Ekofisk Bravo blowout in the North Sea ranged up to 350 ppb (Grahil-Nielsen, 1978). Lesser amounts of oil (probably <20 ppb) were detectable in some samples at a 56-km distance, but not at an 89-km distance.

In the *Exxon Valdez* oil spill (0.258 Mmmb), concentrations of hydrocarbons in the water were not measured in the first 6 days of the spill. However, Wolfe et al. (1994) used an earlier version of the MMS weathering model (Payne et al., 1984) to estimate water concentrations after passage of the storm on the third day of the spill, arriving at an average value of 800 ppb within the top 10 m (33 ft) of the water, in the “effective” or discontinuous spill area. Wolfe et al. (1994) also summarized the actual measurements made in Prince William Sound. Seven to 11 days after the spill, residual concentrations ranged from 67-335 ppb petroleum hydrocarbons, 1.5 ppb volatile organic analytcs (mostly mononuclear aromatics), and 1-5 ppb polynuclear aromatic hydrocarbons (PAHs). Concentrations in Prince William Sound decreased to levels below the chronic criteria levels of concern, to between 1 and 6 ppb petroleum hydrocarbons and 0.1 ppb PAH after 21-41 days. The concentration decreases within these timeframes were attributable to advection and dilution, not decomposition. In restricted waters under very calm seas, however, lack of vertical mixing and dilution can result in higher concentrations, up to 1,000 to 3,000 ppb within the top 1-3 m (3-10 ft) that persist for a day (Baffin Island Oil Spill Project; Humphrey et al., 1987).

The concentrations of oil deeper in the water column are relatively low because oil is only slightly soluble in water and vertical—and especially horizontal—dispersion and consequent dilution would rapidly decrease hydrocarbon concentrations for all but the largest spills in several hours. For spills of the magnitude of the EVOS, hydrocarbon concentrations could remain elevated above chronic criteria for as long as 10-20 days. Aromatic compounds are the most toxic constituents of crude oil, partly because they are the most soluble constituents. The highest rates of dissolution of aromatics from a slick and,

consequently, accumulation in underlying water occur in the first few hours after a spill (Payne, 1987). The bulk of these volatile compounds are lost in <3 days.

At sea, water depth and shoreline do not restrict movement of slick or water, and the slick and underlying water generally move at different angles to the wind. The rate of horizontal dispersion or mixing in the ocean is orders of magnitude greater than the rate of vertical dispersion. By the time dissolved oil worked down 10 m (33 ft) in the water column, it would have spread horizontally and been diluted over a distance of perhaps 10,000 m (5.4 nmi). The slick itself would become patchy, with the total area containing the widely separated patches of oil being orders of magnitude larger than the actual amount of surface area covered by oil.

If the spilled oil were of a composition similar to that of Prudhoe Bay crude, about 40% of the spilled oil could persist on the water surface after the slick disappeared, dispersed into individual tarballs. Slow photo-oxidation and biological degradation would continue to slowly decrease the residual amount of oil. Through 1,000 days, about 15% of the tarballs would sink, with an additional 20% of slick mass persisting in the remaining tarballs (Butler, Morris, and Sleeter, 1976). Because of the drift of the oil over distances of hundreds or thousands of kilometers during the slow process of sinking, individual sunken tarballs would be extremely widely dispersed in the sediments.

The “average” levels of local or regional contamination in sediments would be insignificant. Suspended loads of sediment away from the shoreline (<100 ppm dry weight) are not high enough to appreciably enhance oil removal from the slick or water column (see Payne et al., 1989; Boehm, 1987). Only if oil were mixed into shoreline sediments and then dispersed offshore could elevated concentrations of hydrocarbons occur locally. Regional contamination of offshore sediments would not be detectable.

Under ice, the volatile compounds from a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water underneath the ice. After onset of melt, oil spilled under ice generally tends to reach the ice surface in an unweathered state. However, once formed, a hydrocarbon plume in the water column underneath the ice would persist above ambient standards and background over about a fivefold greater distance than under open water conditions (see Cline, 1981).

For purposes of analysis, the larger of the assumed spill sizes was chosen. The weathering characteristics of the assumed 4,600-bbl oil spill (Table A.1-1) in the summer and during meltout are shown in Table A.1-7. Based on these characteristics, the estimated concentration of oil dispersed in the water column for a summer spill after (1) 3 days is estimated to be 1,740 ppb (assuming a 2-m dispersal depth); (2) 10 days is estimated to be 330 ppb (assuming a 5-m dispersal depth); and (3) 30 days is estimated to be 70 ppb (assuming a 10-m dispersal depth). If the spill occurred in the spring during melting, the environmental conditions affecting the characteristics of a spill would be different from those of summer. The estimated concentration of oil dispersed in the water column for a meltout spill after (1) 3 days is estimated to be 5650 ppb (assuming a 2-m dispersal depth); (2) 10 days is estimated to be 880 ppb; and (3) 30 days is estimated to be 130 ppb (assuming a 10-m dispersal depth). The estimated high concentrations of oil associated with dispersal in the water column may represent an upper range of dispersed-oil concentrations reached during the first several days following a large spill. These concentrations are greater than the 15 ppb that was assumed to be the total hydrocarbon chronic criterion and, after 3 days, less than the 1,500 ppb that was assumed to be the acute criterion. Both the summer and meltout concentrations of oil that are estimated to be dispersed in the water column after 30 days, 70 and 130 ppb, respectively, are within the range of concentrations reported for the larger *Argo Merchant* and *Amoco Cadiz* spills. However, these concentrations are much greater than the previously noted concentrations of petroleum hydrocarbons, 1-6 ppb, in Prince William Sound 21-41 days after the EVOS. The estimated concentration of dispersed oil in the water 30 days after both the summer and meltout spills

is greater than 15 ppb and indicates a relatively long period of time, perhaps about a month or more, before dilution of the dispersed oil reduces the concentrations below the chronic criterion.

4.4.2.1.2. Mitigation Measures. None of the proposed mitigating measures (see Section 2.5) would decrease the already low estimated effects on water quality. Because oil spills from tankers tend to be larger than those from pipelines, the transportation of hydrocarbons by pipelines is preferred by MMS over tankers. The scenario the Proposed Action (Alternative 2) is based on already assumes that pipelines would be used to transport produced oil and gas. Types and amounts of discharges that may impact water quality are regulated by the EPA through NPDES permits. This analysis assumes that development and production wastes would not be discharged.

4.4.2.1.3. Cumulative Effects Under Alternative 2.

4.4.2.1.3.1. Cumulative Effects from Exploration and Development. Water quality regulations ensure that the effects of oil and gas exploration and development activities are minor by restricting the types and amounts of discharges from facilities. Any discharges that are permitted would become diluted rather quickly, so the effects would be local and temporary.

Cumulative Effects from Oil Spills. Oil spills would not significantly degrade the quality of Beaufort Sea water. Even from a large spill, concentrations of hydrocarbons in water would be less than the acute criterion within 3 days of spillage, and concentrations above the chronic criterion likely would persist <30 days. Small spills would degrade the water quality locally for a relatively short period of time, though frequent small spills in an area could result in local, chronic contamination.

Overall Conclusion. The activities associated with petroleum exploitation resulting from proposed Sales 209 and/or 217 would be unlikely to have any substantial effects on water quality. The level of impact on water quality as a result of the proposed lease sales would be minor locally and negligible regionally due to the requirements of EPA and State of Alaska water quality criteria, and the effects would be temporary due to dilution. Proposed mitigation measures would not reduce effects further. The cumulative level of impact on water quality in the Beaufort Sea, including the combined effects of reasonably foreseeable activities and climate change as described in Section 4.4.1.1, would be minor to moderate.

4.4.2.2. Air Quality.

Air emissions from OCS activities would be under the jurisdiction of the EPA, which regulates air emissions as prescribed in 40 CFR 55. For facilities located within 25 mi of a State's seaward boundary, the regulations are the same as would be applicable if the emission source were located in the corresponding onshore area, and would include State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and monitoring. For facilities located beyond 25 mi of a State's seaward boundary, the basic Federal air quality regulations apply, which include the EPA emission standards for new sources and the Prevention of Significant Deterioration (PSD) regulations. The EPA has established national ambient air quality standards (NAAQS) for NO₂, SO₂, PM₁₀, fine particulates <2.5 microns in diameter (PM_{2.5}), carbon monoxide (CO), lead, and ozone (O₃) because of their potential adverse effects on human health and welfare. The health and environmental effects of air pollutants have been summarized by the EPA (EPA, 1979, 1998, 1999a). Ambient levels of NO₂, SO₂, PM₁₀, and O₃ can contribute to respiratory illnesses, especially in persons with asthma and the elderly, and can also aggravate heart disease.

Air emissions from OCS oil and gas development arise from production platforms, drilling activities, construction, support vessels, and helicopters. A comprehensive inventory of air emissions from OCS activities was constructed by Wilson et al. (2004), but it was specific only to operations in the Gulf of Mexico. Nevertheless, the emission factors developed in this study are of use in estimating emissions associated with the proposed lease sales in the Beaufort Sea.

The OCS operations in the Arctic Ocean are unique in a number of ways due to the sea ice that is present much of the year. In very shallow waters (5-10 m deep), exploratory wells may be drilled from an ice or gravel island (USDOI, MMS, 2003a). Construction of an ice island would need to take place in winter, and material and personnel would be carried to the site by vehicles operating on an ice road. In water 10-20 m deep, movable platforms resting on the seafloor may be used for exploration. Drilling operations from these platforms could take place all year. Ice islands are not projected for the Chukchi Sea, because activities there would not occur close to shore. In deeper waters, drillships or floating platforms would be used, and drilling would be limited to a short time period during the summer months. Material and supplies would be ferried using barges or supply boats. In addition, icebreakers would operate in the vicinity of the drilling rig and vessels to control sea ice. Because of the arctic conditions, the pace of development is slower as activities are limited to certain rather narrow timeframes. In shallow waters in the Beaufort Sea, production may take place from gravel islands or bottom-founded structures, while in deeper waters, floating structures anchored to the seafloor would be used. As in the case of exploration, a gravel island would be constructed during winter. The modules for production facilities would be installed during the ice-free period using barges, tugboats, and supply vessels.

4.4.2.2.1. Potential Effects from Routine Air Emissions. In the exploration phase, emissions would be produced by the following:

- vessels used for seismic and other geological and geophysical surveys;
- diesel-power-generating equipment needed for drilling exploratory and delineation wells;
- tugboats, supply boats, icebreakers, crew boats, and helicopters used in support of drilling activities; and
- intermittent operations such as mud degassing and well testing.

Pollutants generated would consist primarily of NO_x, CO, and SO₂. In the analysis, it is assumed that exploration activity would begin in the year following the lease sale, and that up to three seismic surveys could be conducted during the open-water season. Seismic surveys in the Beaufort Sea probably would be coordinated with surveys in the Chukchi Sea to use the same vessels. Typical seismic-survey operations would consist of a large seismic vessel towing airguns and cable arrays and a smaller support boat. Survey times likely would average 20-30 days (with down time) to cover a likely survey area of 200 mi².

Drilling operations would be expected to range between 30 and 90 days at different well sites, depending on the depth to the target formation, difficulties encountered during drilling, and logging/testing operations. Because of the relatively short open-water season in the Beaufort Sea (July-October), a maximum of three exploration wells would be drilled in the open-water season.

In the development phase, including temporary construction operations and drilling, the main sources of emission offshore would be:

- gas turbines used to provide power for drilling;
- production equipment, including boilers, heaters, and storage tanks;
- reciprocating engines used for electrical power, including rig generator (during construction phase only; standby only during commissioning);
- heavy construction equipment used to install facility and pipelines;

- construction- and commissioning-support equipment, including cranes, pumps, generators,
- compressors, pile drivers, welders, heaters, and safety flares; and
- tugboats (needed to move equipment and supply barges), support vessels, and helicopters.

Under the EPA and ADEC regulations, best available control technology would be applied for many of the emission sources. The main emissions would be NO_x and CO, with lesser amounts of SO₂, VOC, and PM. Emissions from development under the Proposed Action would be from the installation of one to three platforms, construction of 15-75 mi of offshore pipeline, drilling of 22-74 production wells, and constructions of 15-70 mi of onshore pipeline to connect to the TAPS. In the peak years, 8-16 wells per year would be drilled from one to two drilling rigs. In the peak year of production, about 44.5-115.9 MMbbl of oil per day would be produced.

In the production phase, the main source of offshore emissions would be from turbines for power generation, gas compression, oil pumping, and water injection. Another source of emissions would be evaporative losses of VOC from oil/water separators, tanks, pumps, compressor seals, and valves. Reduction in VOC emissions would be achieved by equipping produced water and slop-oil tanks with vapor-recovery systems and using valves and seals designed to prevent VOC leakage. The VOC also would be emitted if there were an accidental release of gas (venting). Operators would be required to have a safety flare to safely burn any unexpected releases of natural gas. Flaring gas would be done for safety purposes; but it also would eliminate most of the VOC, although some emissions of NO_x, SO₂, and PM would be released.

Abandonment of facilities after production is no longer viable; it would require heavy equipment, trucks, and barges, which would emit pollutants at levels comparable to the initial construction phase. Because abandonment operations would last a short time and include no activities that would affect air quality more significantly than previous phases, abandonment operations would cause insignificant effects on air quality.

Other sources of pollutants related to OCS operations are accidents such as blowouts and oil spills. Typical emissions from such accidents consist primarily of VOC; only fires associated with blowouts or oil spills produce other pollutants.

Air emissions resulting from a proposed Beaufort Sea lease sale were estimated by using the exploration and development scenario presented in Table B-1 (Appendix B) and applying air-emission factors derived from the permit application for the Shell exploration project (EPA, 2007) and from the Northstar and Liberty development projects (BPXA, 1998a,b). Table 4.4.2.2-1 shows estimated emissions for the various types of activities.

Air quality modeling using the Offshore and Coastal Dispersion model has been performed in past studies to assess impacts from planned lease sales in the Beaufort Sea (USDOJ, MMS, 1996a) and additional discussions of air quality impacts may be found in USDOJ, MMS (1998a, 2003a). The highest predicted onshore annual average NO₂ concentrations were in the range of 0.5-1.5 micrograms per cubic meter (µg/m³), which is well within the PSD Class II maximum allowable increase of 25 µg/m³. Concentrations of SO₂ and PM₁₀ were not modeled; however, when one scales the results according to the respective emission rates, the levels would be well within the PSD Class II increments. Modeling for the Northstar and Liberty projects on gravel islands in the Beaufort Sea (USDOJ, MMS, 2002; U.S. Army Corps of Engineers, 1999) resulted in higher concentrations, because they considered points just outside the facility boundary, but the levels predicted for NO₂, SO₂, and PM₁₀ were still within the PSD Class II limits.

An examination of the air quality analysis performed for the Northstar facility and proposed Liberty development project in the Beaufort Sea will give a measure of the expected impacts over water near an OCS production facility on a gravel island in the Beaufort Sea. The highest predicted concentrations for NO₂, SO₂, and PM₁₀ for the Northstar and Liberty projects occurred within 200 m of the facility boundary and were close to PSD Class II increments (USDOJ, MMS, 2002; U.S. Army Corps of Engineers, 1999). The highest onshore concentrations were considerably lower because of the effect of atmospheric dispersion over distance. The combined facility concentrations for Liberty plus background were well within NAAQS (between 2% and 30% of the standards). The maximum projected throughput per platform for a Beaufort Sea lease sale is lower than that analyzed for the Liberty project. It is likely that air quality impacts would be somewhat lower than those from the proposed Liberty project.

Finally, one could examine the effect on air quality from the most significant sources of industrial emissions in the Alaska Arctic, the Prudhoe Bay/Kuparuk/Endicott oil-production complex. The area was the subject of monitoring programs during 1986-1987 (ERT Company, 1987; Environmental Science and Engineering, Inc., 1987) and from 1990 through 1996 (ENSR, 1996, as cited in U.S. Army Corps of Engineers, 1999). Five monitoring sites were selected; three were considered subject to maximum air-pollutant concentrations, and two were considered more representative of the air quality of the general Prudhoe Bay area. The more recent observations are summarized in Table 4.4.2.2-1. All the values meet Federal and State ambient air quality standards. The results appear to demonstrate that ambient pollutant concentrations from oil and gas development, even for sites subject to maximum concentrations, meet the ambient air pollution standards.

Summary and Conclusion for Effects from Routine Air Emissions on Air Quality. Air emissions from OCS activities resulting from Beaufort Sea Lease Sale 209 or 217 would be subject to EPA and ADEC emission control standards and would have to meet the PSD Class II and the NAAQS. There would be an increase in the level of criteria pollutants, with the highest level within a few hundred meters of the emission source. Pollutants regulated under PSD would consume a certain portion of the Class II increment, but the area affected would be localized and the maximum allowable increment would not be exceeded. Pollutant concentrations would fall off with distance, and onshore impacts would be significantly lower. Air quality impacts would be comparable or lower than those predicted for Lease Sale 144. One can reasonably conclude that the release of criteria pollutants would remain well within PSD limits and NAAQS. Consequently, the air quality impacts would be low.

4.4.2.2.2. Effects from Oil Spills and Accidents. Small accidental crude oil spills would cause minor, localized increases in concentrations of VOC due to evaporation of the spill. Most of the air emissions would occur within a few hours of the spill and would decrease drastically after that period.

Large spills would result in air emissions over a large area and a longer period of time. Large spills could occur from a well facility or pipeline. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill; they examined the rate of evaporation and ambient concentrations of 15 different VOC. A number of these compounds, including benzene, ethylbenzene, toluene, and o-xylenes, are classified by EPA as hazardous air pollutants. The results showed that these compounds vaporize almost completely within a few hours after a spill. Ambient concentrations peak within the first several hours after a spill and are reduced by two orders of magnitude after about 12 hours. The heavier compounds take longer to vaporize and may not peak until about 24 hours after spill occurrence. Total ambient VOC concentrations would be significant in the immediate vicinity of a large oil spill, but concentrations would be much reduced after the first day.

During open-water conditions, spreading of the spilled oil and action by winds, waves, and currents would further disperse VOC concentrations to extremely low levels over a relatively larger area. During

broken-ice or melting-ice conditions, because of limited dispersion of the oil, the concentrations might reach slightly higher levels for several hours, possibly up to 1 day. The effects from a spill occurring under the ice would be similar to but less than those described for broken-ice or melting-ice conditions; the oil would be trapped and essentially remain unchanged until the ice began to melt and breakup occurred. Some VOC emissions, however, would be released from the oil and dispersed, even from under the ice. In any of these situations, surface winds further would reduce VOC concentrations in the air. Concentrations of criteria pollutants would remain well within NAAQS.

Diesel fuel oil could be spilled either while being transported or from accidents involving vehicles, vessels, or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient hydrocarbon concentrations would be higher than with a crude oil spill but would persist for a shorter time. Also, because any such spill probably would be smaller than some potential crude oil spills, any air quality effects from a diesel spill likely would be lower than for other spills.

Any accidental release of oil or gas could catch fire or could be intentionally ignited during cleanup. In situ burning is a preferred technique for cleanup and disposal of spilled oil. Burning could affect air quality in two ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98% and slightly increase emissions of other pollutants. If an oil spill were ignited, it would emit a plume of black smoke containing nitrogen dioxide, SO₂, CO, and PM, but the amount of VOC that otherwise would be emitted through evaporation would be significantly reduced.

In situ burning as part of a cleanup of spilled crude oil or diesel fuel would temporarily affect air quality, but the effects would be low. Fingas et al. (1995) describes the results of a monitoring program of an oil-spill test burn at sea. The program involved extensive ambient measurements recorded during two burns in which approximately 300 bbl of crude oil were ignited. During the burn, nitrogen dioxide, SO₂, and CO emissions were measured only at background levels and frequently were below detection limits. Ambient levels of VOC were high within about 100 m of the fire but were significantly lower than those associated with a nonburning spill. Measured concentrations of polyaromatic hydrocarbons (PAHs) were low. It appeared that a major portion of these compounds was consumed in the burn. Effects of in situ burning for spilled diesel fuel would be similar to those associated with a crude oil spill.

If the gas or oil blowout caught fire or if an oil spill was ignited intentionally to clean up and dispose of the spilled oil, burning would reduce emissions of gaseous hydrocarbons by 99.98% and very slightly increase emissions of other criteria pollutants, relative to the quantities emitted in other industrial operations (see USDO, MMS, 1996a:Table IV.B.12-3). If an oil spill was ignited immediately after spillage, the burn could combust 33-67% of the crude oil or higher amounts of fuel oil that otherwise would evaporate. Incomplete combustion of oil, however, would cause about 10% of the burned oil to be discharged as oily soot into the air. For a major oil blowout, in situ burning may be the only effective technique for spill control. Setting fire to the wellhead could burn 85% of the oil, with 5% remaining as residue or droplets in the smoke plume, in addition to the 10% released as soot (Evans et al., 1987).

The principal contributor of pollution from a fire would be soot. Soot would cling to plants near the fire but would tend to slump and wash off vegetation in subsequent rains, limiting any health effects. Potential contamination of shoreline and onshore vegetation would be limited, however, because exploration and development and production activities under the Proposed Action would be at least 8 nmi offshore, with the exception of any oil- or gas-transport pipelines.

Coating portions of the ecosystem in oily residue is not the only potential air quality risk. Smoke from burning crude oil would contain PAH's. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAHs, is present in crude oil smoke in very small amounts, but in quantities approximately three times larger than in the unburned oil (Evans, 1988). Investigators have

found that, overall, the oily residue in smoke plumes from crude oil is mutagenic, although not highly so (Sheppard and Georghiou, 1981; Evans et al., 1987). McGrattan et al. (1995) reported that smoke-plume models have shown that the surface concentrations of particulate matter do not exceed the health criterion of $150 \mu\text{g}/\text{m}^3$ beyond about 5 km downwind of an in situ burn. This is quite conservative, as this health standard is based on a 24-hour average concentration rather than a 1-hour average concentration. The Expert Committee of the World Health Organization considers daily average smoke concentrations of $>250 \mu\text{g}/\text{m}^3$ to be a health hazard for bronchitis.

Summary and Conclusion for Effects from Oil Spills and Accidents on Air Quality. Over the life of oil and gas exploration, development, and production in the sale area, the likelihood of one or more large oil spills occurring is 40%. Total ambient VOC concentrations would be significant in the immediate vicinity of a large oil spill, but concentrations would be much reduced after the first day. An oil spill could be set on fire accidentally or deliberately. Burning significantly would reduce the VOC concentrations in the area but increase slightly the concentrations of other criteria pollutants. The principle contributor of pollution from a fire would be soot. Potential contamination of the shore would be limited, however, because exploration, development, and production activities under the Proposed Actions would be at least 8 nmi offshore, with the exception of any oil- or gas-transport pipelines. Smoke from an oil fire could have health risks, although the daily average smoke concentrations would be below the level that constitute health hazard for bronchitis. Other air quality effects from cleanup activities would include emissions from vessels, vehicles, and equipment used in the cleanup effort; air emissions from this equipment would be minimal. We conclude, therefore, that the effect on onshore air quality from accidental releases and corresponding cleanup efforts likely would be low.

4.4.2.2.3. Other Effects to Air Quality. Other effects of air pollution from sale-related activities to the environment not specifically addressed by air quality standards include the possibility for damage to vegetation from acidification of coastal areas and reduced visibility. These effects may be short term (hours, days, or weeks), long term (seasons or years), regional (Arctic Slope), or local (nearshore only).

Olson (1982) reviewed susceptibility of fruticose lichen, an important component of the coastal tundra ecosystem, to sulfurous pollutants. There is evidence that SO_2 concentration as low as $12.0 \mu\text{g}/\text{m}^3$ for short periods can depress photosynthesis in several lichen species, with damage occurring at $60 \mu\text{g}/\text{m}^3$. In addition, the sensitivity of lichen to sulfate is increased in the presence of humidity or moisture, conditions that are common in coastal areas.

For their proposed Liberty development project, British Petroleum (Exploration) Alaska (BPXA) found that maximum modeled pollutant concentrations were well below levels that can damage lichens, according to laboratory studies. Research at Prudhoe Bay from 1989 through 1994 showed no effects of pollutants there on vascular plants or lichens (Kohut et al., 1994). Monitoring the vascular and lichen plant communities over the 6 years revealed no changes in species composition that could be related to differences in exposures to pollutants.

Visibility may be defined in terms of visual range and the contrast between plume and background, which determines perceptibility of the plume. For their proposed Liberty Project, BPXA ran the VISCREEN model, which calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions. It found noticeable effects on a limited number of days, ones that had the most restrictive meteorological conditions, but no effects at all during average meteorological conditions.

A significant increase in O_3 concentrations onshore is not likely to result from exploration, development, or production scenarios associated with the proposed sales. Photochemical pollutants such as ozone are not emitted directly—they form in the air from the interaction of other pollutants in the presence of

sunshine and heat. Although sunshine is present in the Beaufort Sea program area most of each day during summer, temperatures remain relatively low (Brower et al., 1988). Also, OCS activities would be relatively small and separated from each other at some distance, diminishing the combined effects from these activities and greatly increasing atmospheric dispersion of pollutants before they reach shore. At a number of air-monitoring sites in the Prudhoe Bay and Kuparuk areas, O₃ measurements show that the highest 1-hour-maximum O₃ concentrations generally are in the range of 0.04-0.09 parts per million (ppm). The highest 8-hour average ozone concentrations would be well below the national standard of 0.08 ppm. Because the projected O₃ precursor emissions from any of the proposed sales are considerably lower than the existing emissions from the Prudhoe Bay-Kuparuk-Endicott complex, the proposed sales would not cause any violations of the O₃ standard.

Community Views on Air Emissions. Elder Bessie Ericklook from Nuiqsut maintained that since the oil fields have been established at Prudhoe Bay, the foxes have been dirty and discolored in the area of Oliktok Point (Ericklook, 1979, as cited in USDO, BLM, 1979a). Leonard Lampe, former Mayor of Nuiqsut, more recently reported further air-pollution problems and habitat concerns, asserting that Nuiqsut has been experiencing such effects for some time:

“A lot of air pollution, asthma, bronchitis—a lot with young children. We see smog pollution that goes from Prudhoe Bay out to the ocean and sometimes to Barrow when the wind is blowing that way....” (Lavrakas, 1996:1, 5).

Summary and Conclusion for Other Effects to Air Quality. Air emissions from a proposed Beaufort Sea lease sale would be subject to the EPA and ADEC pollution control requirements. Air quality modeling of typical OCS activities in the Beaufort Sea has demonstrated that with appropriate emission control technologies, pollutant concentrations would be below the PSD incremental limits and the NAAQS. The highest concentration levels would be localized and onshore concentrations would be significantly lower than the modeled results. Because of the distances from the most likely developments to Beaufort coastal communities and the relatively small sizes of anticipated development in the Beaufort compared to the Prudhoe Bay complex, the proposed sale should have little to no significant effect on the air quality of coastal communities. The effects on vegetation and visibility under the Proposed Action would be low.

4.4.2.2.4. Cumulative Effects Under Alternative 2. The cumulative analysis considers the impacts from future OCS oil and gas development in addition to all other reasonably foreseeable emission sources.

The primary emissions in the Arctic Ocean coastal areas arise from oil production facilities and pumping stations on the North Slope, oil production in state waters, on-road and off-road motor vehicles, power generators, heating systems, marine vessels, and aircraft. While some growth of these activities is likely to take place in the future, overall emissions likely would not exceed present levels. Emission standards on motor vehicles are becoming more stringent, and the EPA has promulgated new standards on nonroad engines and marine vessels. These should result in a downward trend for those emission sources.

On the Alaska North Slope, onshore oil production from the Prudhoe Bay, Kuparuk, Milne Point, Colville River, and Badami fields, and oil production from the Duck Island and Northstar fields in State waters are the largest source of emissions. Production from North Slope reservoirs peaked at about 2 MMbbl of oil per day in 1988, and declined to about 0.9 MMbbl per day in 2005 (U.S. Department of Energy, 2007). Production is predicted to remain relatively steady through 2010 and then decline to about 0.5 MMbbl per day by about 2020 (U.S. Department of Energy, 2007).

Actual annual emissions for Prudhoe Bay, Milne, Endicott, and Lisburne for 1994-1995 were reported to be 56,247 tons of NO_x, 6,199 tons of PM₁₀, 2,648 tons of VOC, and 1,471 tons of SO₂ (U.S. Army Corps of Engineers, 1999). While there are many major emission sources (emissions exceeding 250 tons/year) in these production areas, ambient air quality monitoring in the existing North Slope oil production areas has shown that air pollutant levels are well within Federal and State standards (U.S. Army Corps of Engineers, 1999). No ambient air quality data have been collected in the Beaufort or Chukchi seas. As very few emission sources exist in those areas, air quality should be relatively pristine.

Modeling studies of proposed OCS production plans in the Beaufort Sea show that emissions from a typical oil production facility would result in localized concentrations of NO₂, SO₂, and PM₁₀ that are within the NAAQS and the PSD incremental limits. The highest concentrations occur within about 200 m of the facility and are considerably lower at distances greater than 1 km (USDOJ, MMS, 2001b). Therefore, there would be little cumulative interaction between facilities located more than a few miles apart. Also, as a result of prevailing wind patterns and distance, there was very little cumulative contribution from existing oil production fields in the Prudhoe Bay and Kuparuk units. Cumulative impacts therefore would not differ significantly from those associated with the proposed lease sale.

Impacts from OCS activities on ozone and visibility are discussed in Section 4.4.2.2.4. Cumulative impacts from the OCS program would not differ significantly from those associated with the proposed sales.

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would be expected to occur within a few hours of the spill and decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on air quality is presented in Section 4.4.2.2.2.

A discussion of the effects of in situ burning is presented in Section 4.4.2.2.3. Studies of in situ burn experiments have shown that air quality impacts are localized and short lived, and that pollutant concentrations do not pose a health hazard to persons in the vicinity.

Cumulatively scenario, there could be a slightly larger number of oil spills in the arctic area compared to the predicted number of spills for the Beaufort Sea Lease Sales 209 and 217. However, the effect of an individual spill would not change; only the probable number of spills would increase. The air quality impacts for the cumulative case, therefore, would be the same as those associated with the proposed Beaufort Sea Lease Sales 209 and 217.

Conclusion. The cumulative air quality impacts from existing and future oil production activities on the OCS, State waters, and onshore would result in localized concentrations of air pollutants. The concentrations would be within the NAAQS and the PSD incremental standards. Air quality impacts would be minor. The proposed Beaufort Sea lease sales would make a minor contribution to the cumulative impacts. Air quality impacts from oil spills would be localized and of short duration.

4.4.2.2.5. Emissions of Greenhouse Gases.

Estimates were made of the total emissions of CO₂ and CH₄ for all projected activities associated with the proposed multi-sale program. Emission factors for the various activities were largely based on a comprehensive inventory of air emissions from OCS activities in the Gulf of Mexico for the year 2000 (Wilson et al., 2004). Emissions are given in terms of teragrams (Tg) of CO₂ equivalent, where one Tg is 10¹² grams (10⁶ metric tons).

Table 4.4.2.2-2 lists the total calculated emissions of CO₂ and CH₄ from activities associated with a Beaufort lease sale under the proposed multi-sale program and compares them with the total U.S. greenhouse gas emissions for the year 2005 (USEPA, 2008). The emissions presented are those for the peak period of activity for the lease sale. The projected CO₂ emissions are about 0.006-0.02% of total all CO₂ emissions in the United States for the year 2005. The CH₄ emissions are about 0.0001-0.0005% of the nationwide CH₄ emissions in the year 2005. The combined CO₂ and CH₄ emissions in terms of CO₂ equivalent measures are about 0.005-0.02% of the year 2005 nationwide figures. The estimated global CO₂ emission rate from combustion of fossil fuels for the year 2005 is approximately 28,193 Tg (USEPA, 2008). The U.S. contribution to this total is about 20 percent (USEPA, 2008). The estimated Beaufort Sea lease sale CO₂ emissions are about 0.001-0.004% of the global CO₂ emissions from fossil fuel combustion.

A number of mitigation strategies could be adopted by operators with the goal to reduce greenhouse gas emissions from OCS oil and gas development activities. Use of more energy-efficient engines, turbines, and boilers would reduce CO₂ emissions. Use of gas instead of diesel fuel to provide power on platforms would significantly reduce emissions. However, many operators already primarily rely on produced gas once production starts. More efficient scheduling of transport of material and personnel could lower service vessel CO₂ emissions by reducing the number of vessel and helicopter trips. Application of optimum power settings on vessels would reduce fuel use and, hence, greenhouse gas emissions.

As noted above, the percentage contribution of CH₄ to the nationwide emissions is significantly greater than that for CO₂. Reductions in CH₄ emissions appear to have the greatest potential in achieving reductions of greenhouse gas emissions from OCS sources. Venting natural gas currently contributes about 59 percent to the total CH₄ emissions in the Gulf of Mexico. Fugitive emissions sources contribute another 19 percent. Flaring excess gas rather than venting it would significantly lower overall greenhouse gas emissions from OCS platforms (Herkhof, 2005), though flaring gas would increase CO₂ emissions. More intensive programs to check for fugitive leaks on platforms would also lower CH₄ emissions. Other possible measures to reduce CH₄ emissions would include use of a lighter color of paint on storage tanks to reduce vapor losses and, in cases where crude oil is transported by tanker, use of vapor balance lines during oil transfer operations.

Conclusion. OCS activities associated with the proposed Beaufort Sea lease sale would result in a negligible contribution to U.S and global greenhouse gas emissions.

4.4.2.3. Lower Trophic-Level Organisms.

Summary. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.5). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that

depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of past, present and reasonably foreseeable actions on ongoing climate change, would be major.

4.4.2.3.1. Direct and Indirect Effects under Alternative 2. Lower trophic-level organisms in the Beaufort Sea are subject to the same potential effects that are described for the organisms under Alternative 1 (Sec. 4.4.1.3). The potential effects of Beaufort Sea offshore operations on existing leases were assessed previously in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a:Section IV.C.2) and the Five-Year Programmatic EIS (USDOJ, MMS, 2007c;Section IV.B.3.h). The assessments concluded that the overall level of effect with mitigation would be low, local, and/or short term. The former assessment was updated by assessments for Lease Sales 195 and 202 (USDOJ, MMS, 2004, 2006b). Cumulative effects in the existing environment are summarized in Section 3.3.1.1, including the effect of approved “discharges” such as construction fill, slope-protection fabric, and drilling muds/cuttings in water more than 20 m (65 feet [ft]) deep (see Section 4.4.2.1). Extensive seafloor monitoring has documented substantial interannual changes (e.g., in the Boulder Patch kelp community), but the changes apparently have not been related to the exploration, development, production, and/or abandonment operations to date. The changes might be due to broad-scale changes in the ice cover and climate—changes that are noted also in Sections 3.2.4.3.3.3.1 and 3.2.4.3.3.4.3, for example.

The following sections assess the direct and indirect effects. The sections includes the specific effects of additional seismic surveys (4.4.2.3.1.1) and effects of additional exploration and development (4.4.2.3.1.2), including the effects of oil spills. This section ends with an analysis of the effectiveness of mitigation measures (4.4.2.3.2). The recent sales in the Beaufort Sea have included standard mitigation; however, some of the mitigation is revised for this proposed lease sale, and is analyzed only in this section. The subsequent section (4.4.2.3.3) assesses the cumulative effects under Alternative 2 (the Proposed Action).

4.4.2.3.1.1. Effects from Seismic Surveys. This section assesses the effects of noise from seismic activity. Noise probably would not affect lower trophic-level organisms, but the additional use of ocean-bottom cables (OBC) might affect them. Most seismic surveys have been conducted with towed cables, and the effect of them was assessed recently in the Chukchi Sea Sale 193 EIS (USDOJ, MMS, 2006c:Section IV.C.1.c (2)). It concluded that the effects from seismic surveys with towed cables probably would be immeasurable, but that the effects of specific seismic proposals would be assessed later by MMS. The conclusion is consistent with the results of a recent, detailed review by the Canadian Government on the effects of seismic sound on invertebrates and other organisms (Canadian Department of Fisheries and Oceans [CDFO], 2004). The CDFO review concluded that there are no documented cases of invertebrate mortality (i.e., of adult life stages, as opposed to eggs or larval life stages) on exposure to seismic sound under field-operating conditions. Similarly, the MMS seismic-survey PEA (USDOJ, MMS, 2006a) and the NMFS Biological Opinion for proposed Beaufort Sea 202, dated June 2006 (NMFS, 2006), conclude that invertebrates probably would not be affected, with the possible exception of squid. In summary, the effect of additional seismic surveys with towed cables on benthic and planktonic organisms probably would be immeasurable.

Some shallow-water seismic surveys might use OBCs, and they would disturb special benthic communities. Most of the benthos in the proposed Beaufort Sea lease area is gouged by ice keels, so disturbance by OBCs would not be serious. Exceptions are the highly diverse kelp communities in Stefansson Sound and inner Camden Bay that are protected from ice keels by barrier islands and offshore bars. The Boulder Patch kelp community in Stefansson Sound is probably are the only dense kelp community on the Beaufort OCS, and research has been conducted at a few sites within it for decades (e.g., Dive Site 11). However, surveys for kelp communities have not been conducted in all other

potential OBC-survey areas. Recolonization of disturbed kelp communities would occur very slowly, requiring at least a decade (USDOJ, MMS, 2003a; Konar, 2007).

In summary, unknown kelp communities that are disturbed by OBCs during some additional seismic surveys would recolonize boulders and other hard substrate very slowly (e.g., after a decade) and could cause more serious disturbance at the few long-term research sites (e.g., Dive Site 11 in the Stefansson Sound Boulder Patch). Regardless, the effects of specific seismic proposals under standard regulations (<http://www.mms.gov/alaska/re/permits/stips1-5.htm>) would be assessed later by MMS.

4.4.2.3.1.2. Effects from Exploration and Development. The following section includes the effects of additional seafloor disturbance, including habitat alteration, the effects of additional discharges, and the effects of possible oil spills.

4.4.2.3.1.2.1. Additional Seafloor Disturbance or Habitat Alternation. Additional seafloor disturbances would occur during the anchoring of drilling vessels, the placement of drilling structures, construction of artificial islands, and construction of more pipelines and landfalls. The disturbance would occur around an estimated 8-22 additional wells (see Section 4.2.1 on Exploration and Development Scenario for estimated amounts and distances). The Beaufort Sea multiple-sale EIS concluded that disturbance would have little adverse effect (USDOJ, MMS, 2003a:Section IV.C.2.a(2)). The low level of effect is confirmed by a recent study of benthos around offshore platforms (Terlizzi et al., 2008). They measured benthic-community changes around platforms in a warm-water environment. They found the greatest changes in the benthos around the deepwater (90 m/300 ft) platform, and attributed the changes to attached organisms that fell off.

Some previous assessments did not assume extensive pipeline systems around offshore fields. An extensive offshore pipeline system was assessed only in the Sale 193 EIS, and it concluded that those specific effects probably would be major (USDOJ, MMS, 2007d:Section IV.C.1.c(4)(a)1).

Another recent assessment distinguished the effects of exploration and development, concluding that additional exploration disturbances would be low, unless they were located near any special biological communities, and that development disturbance would be greater because of long offshore pipelines (USDOJ, MMS, 2006b:Sections IV.C.1.c(3)(a)1 and IV.C.1.c(4)(a)1).

Additional exploration disturbance would have little or no effect on planktonic and/or epontic communities in the proposed sale area. However, anchors and construction could affect benthic organisms by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions. Recolonization of ice gouges by clams has shown that recovery likely would occur within a few years (USDOJ, MMS, 2003a:Section IV.C.2.a(2)), as opposed to the decade-long recovery time for the Boulder Patch kelp community (Konar, 2007). On the beneficial side, additional platforms add a three-dimensional structure to the marine environment, thereby providing more habitat for those benthic organisms, such as kelp, that require a hard, secure substrate for settlement. Colonization time likely would be a decade. Hence, the overall effect of additional platforms would be to alter species diversity near the platform in favor of organisms requiring hard substrates over those that do not.

Development of offshore fields would involve the burial of long pipelines and construction of pipeline landfalls or short docks for connection with the existing infrastructure and the TAPS. Short docks also might be constructed for new logistical shore bases (Section 2.4.2.3). An example is the short dock for the Badami oil field in eastern Stefansson Sound and the 1.5-km (1-mi) long East Dock that was constructed in eastern Prudhoe Bay. The length of these docks, relative to the long causeway for the

nearshore Endicott field, is illustrated in Figure 3.4.2-27. East Dock was built about 30 years ago, and there have been many studies of nearshore water quality since then, but none have documented adverse effects on water quality or lower-trophic level organisms due to the dock. Therefore, short docks and short causeways probably would not disturb measurably the hydrologic conditions and lower trophic-level organisms. Subsequent NEPA analysis by MMS and the U.S. Army Corps of Engineers of any development proposals with docks would help to alleviate site-specific effects.

The acreage that would be disturbed during the burial of additional production pipelines can be estimated with the scenario projections (Table B-4; Sections 2.4.4.4 and 4.2.1.1). We estimate that 24 km (15 mi) of subsea flowlines would radiate out from each production host platform, gathering the production from satellite platforms. We also estimate that a single pipeline would be buried from a production host platform to shore over a distance of 110 km (75 mi). Ice has gouged the seafloor in water up to about 50 m (170 ft) deep, so the pipelines in shallow water would have to be buried deep enough to avoid disturbance from ice keels and strudel scour (Section 4.2.1.1). A study of strudel scour near buried pipelines along the Beaufort Sea coast showed that pipeline segments near river deltas were affected by strudel scour (Leidersdorf et al., 2006). The study suggested that radiant heat from the hot-oil pipelines weakened the nearshore ice cover, increasing the number of strudel scours near river deltas. The strudel scour and the unconsolidated soil near the coast (see Section 3.2.3.2.2.5) means that pipelines near river deltas would have to be buried deeply. Deep pipeline trenches in the unconsolidated soil would have to be wide at the top, up to 130 ft wide, as was characteristic of the Northstar pipeline and as estimated for a development pipeline to the Liberty Prospect (USDOJ, MMS, 2002:Section III.C.3.e(2)(b)2b)). If we assume that offshore pipeline trenches would be about half that width (70 ft), about 250-1,000 acres (101-404 hectares) of Beaufort seafloor might be disturbed during the burial of additional production pipelines. As explained in Section 3.3.1, the recolonization time of disturbed benthic areas is slow, and that specifically only about 65% of the benthic organisms recolonized a disturbed area within 9 years (Conlan and Kvitek, 2005). Therefore, this assessment assumes that the recovery time would require slightly more than a decade. In summary, disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms likely would recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later; some assessments might need more accurate information on recolonization and coastal erosion rates.

4.4.2.3.1.2.2. Additional Discharges. This section includes separate sections on the effects of discharges during exploratory versus production phases. A recent study examined the effect the water-accommodated fraction of drill cuttings on three Arctic organisms—a bivalve (clam) and two amphipod (shrimp-like) species (Olsen et al., 2007). They found no effect on the bivalve but effects on both amphipod species. As explained in the description (Section 3.3.1.1), the existing concentration of heavy metals in Beaufort Sea marine mammals and their prey are the focus of an ongoing study at the University of Alaska Fairbanks (Dehn et al., 2002). The study found differences in the total mercury in the livers of ringed and bearded seals from the Alaskan and Canadian Arctic. The authors suggested that those differences were related to differences in prey, because ringed seals eat mostly pelagic organisms (i.e., euphausiids) and bearded seals eat benthic and epibenthic organisms. Dehn et al. observed the variations in mercury over broad regions of the arctic rather than near or far from areas in which there had been approved discharges. Similar monitoring of sediments and lower trophic-level organisms has continued by MMS (Brown, 2005).

Additional exploratory discharges would include an estimated 125 dry tons of drilling mud and 825 tons of rock cuttings per well, and an estimated 8-22 wells per sale (see Section 4.2.1 Exploration and

Development Scenario). The effects of discharges also are summarized in Section 4.4.2.1 Water Quality. The effects of exploratory drill mud and cuttings discharges were discussed during a recent meeting with industry, government, and academic representatives (Shell Exploration & Production Co., 2008). Two of the discussion topics were the terms of existing EPA NPDES discharge permits, and the background concentrations of metals in sediments and the biota along the Alaskan Arctic coast. Detailed information on any proposed discharges on any leases from proposed Sales 209, 212, 217, and 221 would be contained in future exploration plans, including the general toxicity of the discharges, and that information would be reviewed by MMS and EPA (USDOJ, MMS, 2007d:Section IV.C.1.a(4)). The volumes that might be released from Sale 209 leases are similar to the estimated discharge volumes in the Beaufort Sea multiple-sale EIS. The EIS concluded that <1% of the benthic organisms in the sale area and none of its plankton would be affected (USDOJ, MMS, 2003a:Section IV.C.2.a(1)). Generally, the EPA restricts discharges in all water under stable ice, in water <20 m (65 ft) under broken ice, and in open water <5 m (16 ft), because the water circulation is restricted (see Section 4.4.2.1). For example, drill cuttings were not dispersed when discharged during winter from a bottom-founded platform in 11 m (30 ft) of water in inner Camden Bay, as shown by side-scan photographs of the seafloor after removal of the drilling platform (Thurston, Choromanski, and Crandall, 1999). The productivity also is generally higher in coastal water, as explained in Section 3.3.1, and coastal benthic communities are fed on by many marine mammals, birds, and fish that use the coastal areas as a migratory corridor, as discussed in Sections 3.2.2 through 6. Drilling muds are composed primarily of bentonite (clay), but any heavy metals in them might be accumulated by benthic organisms, adding to the body burden in vertebrate consumers. Inorganic mercury accumulated in the sediment near an old platform in the Gulf of Mexico, but the platform did not have the new EPA limits on mercury discharges. In northwest Alaska, the atmosphere is possibly a source of mercury contamination (Garbarino et al., 2002). Total and methyl mercury in zooplankton from the outer Chukchi Sea is relatively low; but apparently it can be accumulated by zooplankton, as shown by those organisms from the Canadian portion of the Beaufort Sea (Stern and Macdonald, 2005). Also, Thurston, Choromanski, and Crandall (1999) observed undispersed drill cuttings on the seafloor in 11 m (30 ft) of water in inner Camden Bay. In general, standard restrictions on additional exploratory discharges in shallow, under-ice water would avoid local contamination in most areas. Regardless, discharge proposals would be reviewed by MMS and the EPA.

The produced fluids might include oil, gas, and water. Produced water probably would be reinjected into a disposal well; but there is no requirement for reinjection, so the effects are discussed briefly. Produced water typically contains polycyclic aromatic hydrocarbons (PAHs) and, therefore, is toxic to organisms, and it would be produced all year during the production phase.

In summary, standard restrictions on exploratory discharges in shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that discharge and reinjection practices would continue; however, any discharge proposals would be reviewed by MMS and EPA.

4.4.2.3.1.2.3. Oil Spills. This section assesses the effects of both small oil spills (several barrels) and a large crude oil spill ($\geq 1,000$ bbl). The general responses to spills are described in Section 4.3.3.1; as explained, cleanup of spills in broken ice still presents substantial challenges, but research is continuing on especially remote sensing of such spills. Another recent study examined the effect of a small, chronic spill, using the water-accommodated fraction of crude oil on a caged Arctic bivalve near the Northstar Island (Olsen et al., 2007). They found no substantial differences in most key hydrocarbon parameters; however, the concentrations of PAHs were substantially higher than the predeployment levels, indicating that the mussels bioaccumulated trace levels of hydrocarbons on a regional basis.

Small spills might occur during operations when, for example, refined fuel oil is being transferred from a barge to a drilling vessel in offshore water (Appendix A, Section 5). Because of the relatively small size of operational spills (Section 4.3.2.2 and Appendix A.1, Section 5.3) and that most of them could be contained, the effects on lower trophic-level organisms probably would be very low, as has been the case near the Northstar Island.

The Beaufort Sea multiple-sale EIS concluded that the effects of a large oil spill on pelagic invertebrates and plants would be very low. This conclusion is consistent with the projected effects on water quality (Section 4.4.2.1). However, if a spill drifts from the open ocean to a coastline, the effects are no longer limited to water-quality related ones. The oil would persist on intertidal habitats for a much longer period (Appendix A.1, Section 2.2.2). Previous assessments explained that the level of effects in those shoreline environments would be greater (USDOI, MMS, 2003a:Section IV.C.2.a(3)). In the current assessment, we update the effect of a large spill. The new likelihood of one or more large spills ($\geq 1,000$ bbl) occurring is described in Section 4.3.2.1.1 and in Appendix A, Section 4.1.4.1. For this assessment, we assume a 1,500-bbl platform spill or a 4,600-bbl pipeline spill, and that the spill might persist on the water surface for a month (Appendix A, Section 4.1.2.1.6 and Table A.1-1).

This EIS concurs with the conclusion that an oil slick in the open ocean would have minimal effects on the plankton and benthos for a relatively short period of time (Appendix A, Section 2). As noted above, this conclusion agrees with the present conclusion of the water quality assessment. However, if a slick drifted to the coastline, it would affect a habitat other than open water; it would affect the intertidal habitat. The effects on the intertidal habitat could persist for a relatively long period of time, so the chance of a large spill contacting the coastline is quantified further. Unless otherwise specified, the OSRA data is summarized for LAs 1-18 and PLs 1-17. The OSRA model estimates a <0.5-18% chance of a large spill contacting the U.S. Beaufort coast within 3 days during summer (Appendix A2, Tables A.2-85 and 86). Within 10 days, the model estimates a three-times greater (<0.5-43%) chance of a large spill from most pipeline or launch areas contacting the U.S. Beaufort coast during summer (Tables A.2-87 and 88). From the data, we draw two general conclusions about effects on lower trophic-level organisms. First, the differences between 3-day and 10-day trajectories highlight the advantages to the organisms of rapid spill response. Second, the chances of contact with their Beaufort intertidal habitats are relatively high compared to the similar chances for launch areas within the proposed Chukchi Sea lease area.

Because the chance of contact is relatively high from Beaufort Sea lease areas, data have been calculated also for some specific portions of the Beaufort coast. For example, the OSRA model estimates a <0.5-18% chance of a large oil spill contacting the intertidal habitat of the ANWR within 3 days during summer (Tables A.2-85 and 86), and a <0.5-51% chance within 30 days (Tables A.2-89 and 90). The chance of contact with the intertidal habitat is relatively high for both nearshore and offshore launch areas (e.g., LAs 17-20), in contrast to the western Beaufort where the chance of contact with the intertidal habitat is relatively high only for nearshore launch areas (e.g., LAs 2, 4, 6, 8, 10, and 12) (Tables A.2-87 and 88).

Even though the persistence of spills is short in the planktonic habitats, we assessed the risk to two pelagic habitats that are productive and usually grazed by bowhead whales. They are areas along the coast to the east of Barrow and of Kaktovik (Section 3.2.1). The areas correspond to the environmental resource areas for Barrow and Kaktovik subsistence whaling areas (ERAs 42 and 44, Maps A.1-2a and 2c). The OSRA model estimates a <0.5-39% chance of a large spill contacting ERA44 (Kaktovik) within 30 days during summer (Appendix A.2, Tables A.2-65 and 66). Further, the model estimates a <0.5-68% chance of a large spill from any launch area within the proposed Beaufort lease sale area contacting ERA42 (Barrow) within 30 days during summer (Tables A.2-65 and 66).

Further, the likelihood of a spill contacting plankton in Canadian territory can be estimated with ERA 22, a sea segment to the east of the U.S./Canada border area. The OSRA model estimates that the annual chance of a large spill contacting ERA22 is <0.5-12% within 30 days (Tables A.2-5 and 2-6). The OSRA model estimates a <0.5-3% chance of a large oil spill contacting the Canadian Beaufort coast within 3 days during summer (Tables A.2-85 and 86), and <0.5-28% chance within 30 days (Tables A.2-89 and 90).

If any large spill in the proposed lease area drifted to intertidal habitats, it probably would affect several miles of them and probably would persist for a long time. A 1,500-bbl spill of crude oil during summer is estimated to affect 29 km (18 mi) of coastline (Table A.1-6). Most of the U.S. Beaufort coast is exposed to storm waves, so it is eroding, especially since the retreat of the ice pack due to climate change. Oil would persist less than a year on exposed, high-energy coastlines that are eroding (Appendix A.1, Section 2.2.2). However, the large Canning, Sagavanirktok, and Colville river deltas are composed primarily of sheltered tidal flats, sheltered vegetated low banks, marshes, and low-lying tundra in which oil would persist for many years (Research Planning, Inc., 2003). The persistence of oil in arctic marshes and tidal flats is discussed further in the Beaufort Sea multiple-sale and Sale 195 EISs; they conclude that oil would persist in such habitats for more than a decade (USDOJ, MMS, 2003a:Section IV.C.2.a(3)(b)1)). A recent study helps to refine the persistence in Arctic intertidal habitats. The study examined the site of the Baffin Island oil spill, which was a small experimental oil spill on the northern tip of Baffin Island (Prince et al., 2002). The study site is in the “high” arctic compared to the Alaskan Beaufort Sea coast; for example, the Baffin Island intertidal habitats are frozen for about 10 months per year. Prince et al. describe bacterial degradation as the only *in situ* biological process on the oil that became buried in the shoreline sediment. The Baffin Island study concluded that the vast majority of the initial oil was gone within 2 decades after the spill, but that there remained small patches of essentially unaltered oil. Other effects of, and responses to, arctic oil spills are discussed in Section 4.3.2. A general conclusion about Arctic oil spills is described in a recent international report (AMAP, 2007). The AMAP authors, who included U.S. Federal representatives, concluded generally that “spills are the largest threat in the arctic marine environment” and that “responding to arctic spills is a challenge.”

The MMS regulations would help to prevent spills and to reduce the effects of any that occur. The MMS regulations require operators to prepare an Oil-Spill-Response Plan (OSRP) as part of their Exploration Plan (EP) (30 CFR 250.42); the OSRP is reviewed by MMS at the same time that the EP is reviewed. Some previous OSRPs that were approved for operations in the Beaufort Sea included the voluntary storage of response equipment on site (i.e., near wildlife-concentration areas) to speed responses. The Federal Oil Pollution Act of 1990 would help to reduce spill effects. The Act would require operators to conduct drills to demonstrate readiness. Again, these regulations would help to prevent spills, which generally are difficult to recover in water with sea ice. The regulations are important to lower trophic-level organisms, because the main effects on the organisms would be spill related. As explained above, if a spill contacted the coastline, oil would persist in the intertidal and subtidal zones. This assessment estimates that there is <0.5-43% chance that a spill would contact the Alaskan coastline within 10 days, but that the maximum chance is only 18% for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.5).

In summary, the OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring over a 20-year production life of any field (Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup would present substantial challenges (Section 4.3.3.1.7). If a spill occurs during summer, there is a <0.5-43% chance that a spill would contact the Alaskan coastline within 10 days. The maximum chance is only 18% for a 3-day trajectory; the difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If such a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a

few noneroding areas for a couple of decades. Organisms that inhabit these areas would probably experience larger and longer term effects than pelagic or benthic organisms.

Overall, we conclude that the level of direct and indirect effects of foreseeable, unmitigated operations on lower trophic-level organisms would be minor.

4.4.2.3.2. Mitigation Measures. Section 4.4.2.3.1.1 explains that additional OBC seismic surveys could disturb unknown kelp communities, and that the disturbance of a few long-term research sites would be irreversible. The section explained also that pipeline installation could affect unknown special biological communities (e.g., kelp communities), leading to a major level of effect. The MMS has required surveys for special biological communities per a stipulation for the Protection of Biological Resources in previous Alaska OCS lease sales. As explained in the previous Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a:Section II.H.1.a): “This stipulation lowers the potential adverse effects to lower trophic-level organisms, primarily unknown kelp communities, or other unique biological communities, that may be identified during oil and gas exploration or development activities and provided additional protection.” The description of the Beaufort Sea environment (Section 3.3.1) identifies another unique habitat that relates to this old stipulation. The section explains that it is still unknown if there are any pockmark communities within the proposed sale area. The stipulation is not included in the proposed sale for reasons that are explained in Section 2.2, so the level of direct and indirect effects of foreseeable mitigated operations on lower trophic-level organisms would be the same—minor.

4.4.2.3.3. Cumulative Effects Under Alternative 2. This section assesses the cumulative effects of OBC seismic surveys and of exploration and development operations, plus the cumulative effect of climate change and cumulative benefits of mitigation on previous leases.

4.4.2.3.3.1. Cumulative Effects from OBC Seismic Surveys. Unknown kelp communities that are disturbed by OBC during additional seismic surveys would recolonize boulders and other hard substrate within a decade, but if the disturbance affects the few long-term research sites (e.g., Dive Site 11 in the Stefansson Sound Boulder Patch), the consequences would be irreversible for the research. Regardless, the effects of specific seismic proposals under standard regulations (<http://www.mms.gov/alaska/re/permits/stips1-5.htm>) would be assessed later by MMS.

4.4.2.3.3.2. Cumulative Effects from Exploration and Development. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting up to a thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms likely would recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later; some assessments might need more accurate information on recolonization and coastal erosion rates. The effects on previous leases would be reduced by the old stipulation for Protection of Biological Resources.

Standard restrictions of exploratory discharges in shallow and under-ice water <20 m deep would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that the discharge and reinjection practices would continue; and any discharge proposals would be reviewed by MMS and EPA.

4.4.2.3.3.3. Cumulative Effects from Oil Spills. The OSRA model estimates the chance of one or more spills \geq 1,000 bbl occurring over a 20-year production life of any field (see Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup responses would present substantial challenges (Section

4.3.3.1.7). If spills occur during summer, there is <0.5-43% chance that they would contact the Alaskan coastline within 10 days. The maximum chance is only 18% for a 3-day trajectory; the difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If such spills contact the coastline, the oil probably would affect an estimated 29 km of coastline, persisting in noneroding areas for more than a decade. Some lower trophic-level organisms would experience a larger level of effect than others.

As described in the previous Arctic multiple-sale EIS (USDOJ, MMS, 2003a:Section V.A.6), MMS would agree with a synthesis of oil field development in the Arctic that includes the Boulder Patch kelp community (Truett and Johnson, 2000). This historical assessment concluded that the oil-field ecosystem continued to function much as it did prior to exploration and development, constrained primarily by the forces of climate, landscape structure, and nutrient availability and cycling. Any potential evidence of local effects had been obscured by the much greater changes caused by natural phenomena (Truett and Johnson, 2000). Part of our general conclusions of this cumulative analysis was and still is that: “Potential cumulative effects on...boulder patch (kelp habitats)...would be of primary concern and warrant continued close attention and effective mitigation practices.”

Mitigating Measures on Previous Leases. Section 4.3.3.1.7 explains that, if a spill in broken ice, cleanup would present substantial challenges. The OSRA model shows that the chance of a spill contacting planktonic whale prey in the bowhead migration corridor increases from 3 days to 10 days. On previous Beaufort Sea leases, MMS has required a stipulation about a Pre-Booming Requirement for Fuel Transfers. As explained further in the Beaufort Sea multiple-sale EIS (USDOJ, MMS 2003a:Section II.H.1.c): “This stipulation would lower the potential effects to...lower trophic-level organisms...by providing additional protection...from potential fuel spills that may occur just prior to or during the bowhead whale-migration period. A similar procedure is part of the Northstar fuel-transfer plan.”

Such a pre-booming requirement would help to reduce the effects of fuel spills on plankton in the bowhead whale-migration corridor, as was assessed in a previous Environmental Assessment (USDOJ, MMS, 2002:13). The following is an excerpt from this assessment of the proposed exploration with the Mobile Offshore Drilling Unit at the McCovey Prospect about 8 km (5 mi) of Cross Island:

The proposed transfer of approximately 10,000 barrels of diesel fuel from a barge to the MODU could present the possibility of an open-water spill. The transfer would occur during late August at the drill site, which is within the bowhead migration corridor and near a subsistence whaling area. Spilled diesel fuel would probably evaporate from the water column within a week—before the main bowhead migration in mid-September—but traces might remain longer in the shallow sediments around the adjacent islands.

The USCG requires such pre-booming in some harbors. In general, a pre-booming requirement would be effective at impact reduction on existing leases along the Beaufort Sea coast, and especially on leases near the coastal band of high production. In offshore portions of the Beaufort Sea lease area and in the offshore Chukchi Sea lease area, production is lower and the distance to the coastline is greater, so such a requirement would not reduce impacts as effectively. With a pre-booming requirement on leases near the Beaufort coast, the cumulative level of effect due to spills would be slightly lower than minor.

Overall Summary. Three aspects of the proposed lease sales that might affect the organisms are physical disturbance, discharges, and spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would recolonize most of the disturbed areas within approximately a decade, similar to the slow recolonization

rate of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later, some assessments might need more accurate information on recolonization and coastal erosion rates.

Standard restrictions on exploratory discharges in shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that discharge and reinjection practices would continue; however, any discharge proposals would be reviewed by MMS and EPA.

The OSRA model estimates the chance of one or more large spills $\geq 1,000$ bbl occurring over a 20-year production life of any field (see Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup would present substantial challenges (Section 4.3.3.1.7). This assessment estimates that there is a <0.5-43% chance that a summer spill would contact the Alaskan coastline within 10 days, but that the maximum chance is only 18% for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. Organisms that inhabit these areas would probably experience larger and longer-term effects than pelagic or benthic organisms.

Overall Conclusion. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of past, present and reasonably foreseeable actions on ongoing climate change, would be major.

4.4.2.4. Fish Resources.

Summary. Seismic activities and other exploration activities resulting from existing and additional leases being offered throughout the entire lease sale area (no deferrals) on fish resources are not expected to exceed a minor level of effect. Additional leasing in the Beaufort Sea is could result in a small increase the level of seismic survey and other exploration activity, but the anticipated level of effects are the same as for Alternative 1, except that these effects may extend further into the future on new leases. Large petroleum spills are anticipated to only occur following production. Adverse effects to fish resources from petroleum spills would range, in almost all instances, from are anticipated to result in a moderate level of effect. A major level of effect is anticipated to result if large numbers of a discreet population, such as an entire year-class of juvenile fish from a population, were impacted simultaneously. Effects due to climate change may benefit some fish species and harm others. We anticipate that climate change may have a major level of adverse effect to some fish resources in the Arctic. While some oil and gas

production from the Proposed Action may occur in the distant future, the Proposed Action is not anticipated to effect climate change.

The following analysis describes the anticipated effects to fish resources that are most likely to occur if MMS opens the entire lease sale area in the Beaufort Sea without any deferral areas and considering the lease stipulations and other mitigation measures described below.

4.4.2.4.1. Potential Effects to Fish Resources. The potential effects to fish resources in the Beaufort Sea were described in Section 4.4.1.4.1 and are not repeated here.

4.4.2.4.2. Mitigation Measures. The potential effects can be moderated by application of the relevant mitigation measures and lease stipulations (Appendix F) listed below in addition to state and local measures described in Section 4.4.1.4.2.

There are three primary mitigation measures that would avoid or minimize adverse effects to fish resources. The first one is Stipulation 2 (Appendix F), which allows seismic survey activity in the Ledyard Bay Critical Habitat Area until July 1 of each year. Any adverse effects to fish resources from seismic surveys and associated vessel noise would not occur in the Ledyard Bay Critical Habitat Area after July 1. This also applies to other vessels transiting the Chukchi Sea to accomplish MMS-authorized work in the Beaufort Sea.

The second mitigation measure is the ramping-up of seismic airguns. Ramping up conceptually allows fish to move away from a lower level of underwater noise before the noise level is increased to the full performance range. Also, seismic operations are required to remain at least 15 mi away from other concurrent seismic operations to limit the interference with data collection. Separation of concurrent survey operations indirectly benefits fish resources by conceivably allowing fish to move freely between these zones of potential displacement.

4.4.2.4.3. Anticipated Effects under Alternative 2. In this section, we determine the anticipated level of effect on fish resources if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. These anticipated effects consider mitigation measures described above. We defined the terms used to describe the anticipated level of effect in Section 4.4.1.4.3. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.2.4.3.1) and cumulative effects (Section 4.4.2.4.3.2).

4.4.2.4.3.1. Direct and Indirect Effects under Alternative 2.

4.4.2.4.3.1.1. Anticipated Level of Effect from Underwater Noise. Underwater noise can be generated from vessels, seismic surveys, and activities from exploration or production (including drill rig and construction noise).

Vessel Noise. The potential effects on fish resources from vessel noise were described in Section 4.4.1.4.1.1.2. Vessel traffic associated with the Proposed Action is chiefly during ice-free conditions. Vessel traffic may disturb some fish resources and their habitat during routine oil and gas exploration and development operations; however, vessels and their associated noise is transient; fishes in the immediate vicinity of such vessels are believed likely to avoid such noise perhaps by as much as several hundred meters away. The amount of vessel traffic associated with these activities is anticipated to remain fairly constant as existing and potential future leases are explored and resources delineated. Consequently, the level of effect directly attributable to vessels associated with the Proposed Action would be the same as was determined for Alternative 1.

Seismic-Survey Noise. Potential effects to fish resources from seismic survey activity are presented in Section 4.4.1.4.1.1.2. Ramp-up procedures would mitigate some effects by allowing fish to avoid being in close proximity to airguns. Avoidance behavior that results in fish displacement from preferred habitat would be temporary. Because survey activities are limited by availability of seismic-survey vessels and similar survey resources and a limited open-water season, and are further constrained by mitigation measures that regulate concurrent surveys, effects from the Proposed Action would not be appreciably greater than the no-action alternative. Seismic surveys conducted in association with the proposed Beaufort Sea Lease Sales 209 and 217 would have no more than a minor level of effect on fish resources.

Oil and Gas Exploration or Production Noise. Underwater noise is produced during exploratory and production drilling. If fish were disturbed by underwater noise emitted from the drill rigs, similar to reactions described in Section 4.4.1.4.1.1.3, fish could move away from the source of the noise, effectively being displaced from a zone around the drill rig.

Noise-related disturbance effects to fish and direct loss or degradation of fish habitats likely would occur during construction in the marine environment (e.g., well sites, platform placement, pipeline trenching or burial) and at freshwater sites (pipeline and maintenance road construction). This vessel activity would be infrequent and be generally restricted to an area between the drill site and a land-based support site. Effects from these activities would be similar to those described in Section 4.4.1.4.3.2.1.

4.4.2.4.3.1.2. Anticipated Level of Effect from Habitat Loss. The activities that are anticipated to result in habitat loss include drilling and construction effects in marine and freshwater habitats

Effects would be localized as leases are explored and developed. Exploration and production wells, production platforms and pipeline placement would result in a direct loss of seafloor habitats at the placement sites, but these sites are relatively small compared to the amount of similar habitats available to fish in the marine environment. The anticipated effects from facility construction are the same as those presented in Section 4.4.1.4.3.2.2. A minor level of effect is anticipated.

Community Development. Community development is not considered to be a direct effect of the Proposed Action.

Industrial Development. Industrial development activities considered under the Proposed Action include exploration and the potential development of oil and gas resources resulting from additional federal leases in the Beaufort Sea. These activities could include potential perturbations to fish resources such as noise (assessed in Section 4.4.2.4.3.1.1), drilling discharges (assessed in Section 4.4.2.4.3.1.2), and facility construction (assessed in Section 4.4.2.4.3.1.2). These activities are anticipated to have no more than a minor level of effect on fish resources.

4.4.2.4.3.1.3. Anticipated Level of Effect from Petroleum Spills. Adverse effects on fish resources from petroleum spills can occur in both freshwater and the marine environments. Depending on the timing, location, and size, a spill in the marine environment that reaches the nearshore environment has the greatest potential to affect relatively large numbers and multiple species of fish. Similarly, a large spill occurring in freshwater, at a pipeline river crossing for example, also has the potential to affect large numbers of fish. Vulnerability to a spill's effects will vary, depending upon the level of exposure and the fish species' life stages and habitat preferences or requirements. Section 4.4.1.4.1.5 (Potential Effects of Petroleum Spills) addresses these variables.

4.4.2.4.3.1.3.1. Oil Spill Analysis. This section references the OSRA model to discuss the percent chance that a large oil spill from a Beaufort Sea lease sale area could contact Environmental Resource Areas (ERAs) or Land Segments (LSs) that are important to fish resources.

No large oil spills are assumed to occur during exploration activities, including seismic survey activity. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4. In the following sections we assess the effects on fish resources if a large spill were to occur. Combined probabilities combine the percent chance of a spill occurring and then combining that with the percent chance that spilled oil could contact areas important to fish.

Conditional Probabilities. The following sections present conditional probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting specific ERA or LS (shoreline area representing nearshore fish habitats). Conditional probabilities are based on the assumption that a spill has occurred (Appendix A). Combined probabilities, on the other hand, factor in the chance of one or more large spills occurring and then contacting. The assessments for fishes were based on conditional probabilities. The resultant summaries recognize that models are simulations representing typical or average interactions of highly variable factors, and are used here in a broad sense in drawing conclusions about anticipated effects on fish resources.

Appendix A.1 describes the many facets of oil-spill assessment pertaining to the proposed leasing actions. Maps A.1-3a and A.1-3d show the location of the land segments dividing the Beaufort and Chukchi coastline for analytical purposes. Land segments and the geographic place names within the land segments are shown in Table A.1-18. Conditional probabilities of a large spill contacting any of the various land segments are reported in a suite of tables contained in Appendix A.1 of the multiple-sale EIS. There are numerous instances and probabilities whereby oil may contaminate intertidal/estuarine substrates and waters that may be used as spawning and/or rearing habitat by anadromous fish. The PAHs in weathered oil contaminating such spawning sites can be biologically available for long periods and very toxic to sensitive life stages.

For the development and production phases, the fate and behavior of a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A.1). The 1,500-bbl spill would cover a smaller discontinuous area (181 km²) (Table A.1-6) than a 4,600-bbl spill (320 km²) (Table A.1-7) after 30 days. The OSRA model uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific ERAs would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed for potential effects on fish and fishery resources.

Approximately 40% of a 4,600-bbl spill during the open-water period would remain after 30 days, covering a discontinuous area of 320 km². An estimated 49 km of coastline could be oiled. A spill during broken ice in fall or under ice in winter could melt out in the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period could remain after 30 days, covering a discontinuous area of 252 km². An estimated 54 km of coastline could be oiled.

Summer Spill. The OSRA model estimates a <0.5-9% chance that a large oil spill starting at LAs 1-25 contacts land segments (LSs) within 30 days containing streams noted for the presence of chum salmon: LS87 (Meade River), LS94 (Fish Creek), LS95 (Colville River and Delta), LS99 (Sagavanirktok River), and LS103 (Canning River) (Table A.2-77). The model estimates a <0.5-7% chance of contact from PLs 1-17 (Table A.2-78). Pink salmon have been documented as being present in Fish Creek; the Meade, Colville, and Sagavanirktok rivers; and in the Staines River (LS102), Chipp River (LS87), and Ikpikpuk River (LS89) along the Beaufort Sea coast. The highest percent chance of contact is 9% for LS89 (Meade River) from LA2 within 30 days. The chance of contact for this land segment is highest, because the

OSRA model's launch area and the salmon stream are in close proximity to each other (Maps A.1-3c, A.1-4). The highest percent chance of contact is 8% for LS89 (Ikpikpuk River) from PL 8 within 30 days. As with the launch areas, the chance of contact with this land segment is highest, because the OSRA model's pipeline segment and the salmon stream are in close proximity to each other (Maps A.1-3c, A.1-4).

After 360 days, the OSRA model estimates that the chance of a large spill from launch areas contacting a land segment important to pink and/or chum salmon generally increased 5% or less (Table A.2-77). The OSRA model estimates that LS94 (Fish Creek) experienced the greatest increase going from 30 days to 360 days. For pipelines, the greatest increase after 360 days also occurred at LS94 (Fish Creek), which increased 3% for spills from three different pipelines (Table A.2-84). Other land segments, noted for the presence of salmon, generally increased <3% when comparing 30 days to 360 days.

Salmon streams in particular are highlighted for their importance as essential fish habitat; however, diadromous fish species also inhabit many of the streams along the Beaufort Sea coast (Table A.1-18). The OSRA model estimates some of these streams have significantly higher chance of contact from a large oil spill emanating from launch areas or pipelines than the salmon streams listed previously. The OSRA model estimates the highest percent chance of contact is 18% at 30 days post-spill and 19% at 360 days post-spill for both LS91 and LS110 for launch areas (Tables A.2-77 and 83), both containing streams noted as Dolly Varden rearing locations. Similarly for pipelines, the highest percent chance is 14% 30 days post-spill at LS110 and 15% 360 days post-spill at LS107 (Jago River), both documented as having Dolly Varden present.

While anadromous fish streams are relatively easy to identify, there are many other nearshore resource areas that are important to fish. For example, lagoons, river deltas, and estuaries are important to rearing fish, including outmigrating juvenile salmon. On a larger scale, capelin and sand lance use beaches along the coast for spawning. Shoreline habitats are predominantly fine-to medium-grained sand beaches or mixed sand and gravel beaches. A large spill could impact an estimated 49 km of shoreline during a summer release and 54 km of shoreline as a meltout spill (winter release into/under ice) (Table A.1-7). The OSRA trajectory model predicts movement of a surface slick but does not assess subsurface transport of oil in water or tarballs onto beaches, or the persistence of oil once it has been transported to spawning beaches, rearing areas, or spawning streams.

The OSRA model estimates a large spill from offshore LA8 has a 33% chance of contacting ERA86 (Harrison Bay) and a 36% chance of contacting ERA87 (Colville River Delta) within 30 days (Appendix A, Table A.2-65). The percent chance of contact increased 2% at each environmental resource area location after 360 days to 33% and 38%, respectively (Appendix A, Table A.2-71). For PL9, the OSRA model estimates a 44% chance of contact to ERA86 (Harrison Bay) within 30 days and 46% within 360 days (Table A.2-72).

Finally, as the Beaufort Sea Sale 209 and 217 area is adjacent to the Chukchi Sea, the OSRA model estimates the chance of a large spill originating in the Beaufort Sea contacting anadromous streams along the Chukchi Sea coast (LSs 40-44, 47, 49, 51, 53-60, 64, 67, 70-72, or 74) is <0.5%.

Winter Spill. For winter conditional probabilities, the OSRA model estimates a <0.5-5% chance that a large oil spill starting at LAs 1-25 contacts land segments containing streams important to anadromous fish within 30 days (Tables A.1-18 and A.2-125). Because of landfast ice along the coastline, a large spill could be prevented from contacting the shoreline at almost all locations during winter months. After 360 days, the OSRA model estimates the percent chance of contact to land segments important to chum or pink salmon increases; the chance of contact after 360 days ranges from <0.5-12% (Tables A.1-18 and A.2-131). The two land segments with salmon streams that have the highest percent chance of contact

after 360 days are LS94 (Fish Creek), which has a 12% chance of contact from LA8, and LS103 (Canning River), which has a 9% chance of contact from LA17. In general, the primary concern is that a large oil spill may contaminate intertidal/estuarine substrates and nearshore waters that may be used as spawning and/or rearing habitat by diadromous fish. Diadromous fish species inhabiting many of the streams along the Beaufort Sea coast, therefore, could be exposed to oil after meltout. Overall, the OSRA model estimates the highest percent chance of contact from launch areas during a winter spill is 5% at 30 days post-spill and 17% 360 days post-spill from LA18. This occurs at LS110, which contains streams noted for the presence of Dolly Varden. The OSRA model estimates very similar results for pipelines, where LS110 has the highest percent chance of contact after 30 days (4%) and 360 days (13%) post-spill (Tables A.2-126 and 132).

The OSRA model estimates a large spill from offshore LA8 has a 22% chance of contacting ERA86 (Harrison Bay) and a 32% chance of contacting ERA87 (Colville River Delta) within 30 days (Table A.2-113). After 360 days, these percentages increase to 34% and 37%, respectively (Appendix A, Table A.2-119). Similarly, the OSRA model estimates that a large spill originating from PL9 has a 36% chance of contacting ERA86 within 30 days (Table A.2-114). The highest percent chance of contact to ERA87 is from PL10, where there is a 14% chance of contact within 30 days (Table A.2-114).

There are numerous instances and probabilities whereby oil may contaminate intertidal/estuarine substrates in waters that may be used as spawning and/or rearing habitat by pink salmon or capelin. PAHs in weathered oil contaminating such spawning and rearing sites potentially can remain both biologically available for long periods and toxic to sensitive life stages. Lethal effects, or sublethal effects reducing growth, reproductive fitness, or overall survival, therefore, also may persist.

Combined Probabilities. Combined probabilities factor in the chance of one or more large spills occurring and then contacting an ERA or LS. The OSRA model estimates the chance of one or more large spills occurring and contacting land segments with streams noted for the presence of chum salmon or essential fish habitat is <0.5% within 30 days (Table A.2-158). The chance of one or more large spills occurring and then contacting ERAs 86 and 87 ranges is <2% within 30 days over the 20-year production life of the project (Table A.2-158).

Chronic Small-Volume Spills. Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. Small or low-volume spills are defined as <1,000 bbl. The average small crude-oil spill size is 126 gal (3 bbl). An estimated 89 small crude oil spills would occur during the 20-year oil-production period (Table A.1-30), an average of more than 4 per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined-oil spills would occur during the 20-year oil-production period (Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume crude and refined oil spills would occur each year of production. It is unknown how many small-volume spills or what total volume would reach areas used by fish in the nearshore coastal areas. These spills would be subject to the same environmental factors that influence the trajectory analysis (currents, wind patterns, etc.). If these small-volume spills occurred during beach spawning events or incrementally harmed resident fish in the same location on a recurrent basis, reproductive success for certain species could be reduced. If these spills remained unchecked and were to repeatedly reach fish during sensitive life stages, depression of recruitment, over time, could result in reduction, displacement, or elimination of fish from the affected area.

While small-spills are required to be reported, the number of unreported spills is unknown. Not all spills would be expected to receive a spill-response. Overall, it is unclear whether, over the long-term and in the absence of a monitoring program to assess effects, any negative impacts to fish resources from chronic small spills would be detected.

4.4.2.4.3.1.3.2. Effects from Oil-Spill Response. Conditional probabilities do not factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Oil-spill response could originate from Deadhorse, about 150 mi east of Barrow. Specific resource-protection activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with State officials on fishery-management issues in the event of a spill, including the need, for example, to boom the entrances to salmon-spawning streams and streams with important subsistence species. Effectiveness, however, could be expected to improve if spill-response equipment were staged closer to the site of a potential spill.

General Summary. Exploration activities would not typically present a spill threat. A large spill, not considered reasonably foreseeable during the leasing and exploration stages, could affect relatively large numbers of fish and multiple fish species but, because of their numbers and relatively broad geographic distribution, effects to arctic fish species and fish populations in the Beaufort and Chukchi seas most likely would range from a negligible to moderate level of effect. The greatest chance for a petroleum spill to have a major level of effect on a fish population would be if genetically distinct or uniquely isolated and vulnerable fish populations were impacted by a spill. For instance, young-of-the-year arctic cisco from the Mackenzie River, being driven westward by wind-driven currents to waters off Alaska's North Slope, would be especially vulnerable a large petroleum spill in the eastern Beaufort Sea, if these juvenile fish were concentrated in a spill-impacted area. Pink and chum salmon appear capable of slowly expanding their range in the Arctic. Regardless of whether or not this expansion is considered an ecologically positive event, a petroleum spill could delay this range expansion by contaminating limited freshwater, intertidal, or estuarine spawning habitats.

4.4.2.4.3.1.4. Anticipated Level of Effect from Changes in the Physical Environment.

Successful oil and gas development and production resulting from Lease Sales 209 and 217 is possible; however, the lease sale is not expected to have a direct effect on physical changes in the arctic environment or worldwide trends in demand, production, and consumption of hydrocarbons. Climate change will continue to affect marine, estuarine, and freshwater fish resources, including effects to fish distribution, abundance, foraging and migrational patterns, and increased oxygen-consumption rates regardless of whether development occurs in the Arctic or elsewhere in the world. These trends are expected to continue and, over time, a major level of adverse effect is anticipated; however, the Proposed Action is not anticipated to effect climate change.

4.4.2.4.3.2. Cumulative Effects under Alternative 2. Lease Sales 209 and 217 could result in a small increase in the number of leases in the Beaufort Sea OCS but, based on history, some of the leased tracts will not be explored and some that are explored will not be subjected to further evaluation or development. Because of the limited timing and resources available for seismic exploration and open-water exploratory drilling at active lease locations, these activities are anticipated to continue at present levels for the foreseeable future, even if more leases are issued. Effects to fish resources from oil and gas infrastructure development on land and in State waters, unrelated to OCS activity, will continue to have a negligible to minor level of effect. Any associated increases in vessel traffic in support of these efforts and other research and tourism vessel traffic would increase the potential for marine accidents and fuel spills. Onshore oil and gas development also will increase the chance of accidental spills affecting freshwater habitats important to diadromous and freshwater fish. These effects are the same as those identified for Alternative 1.

Climate change could benefit or harm some fish species by making habitat in the Alaskan Arctic more or less hospitable for feeding, overwintering, and reproduction. In contrast, cryopelagic species, including their prey, and species that are uniquely adapted to life in the Arctic, may find climate changes to be extremely detrimental due to loss of habitat and prey and from increased competition and predation from species extending their range into the Beaufort Sea. Climate change may already be causing changes in the diversity and abundance of arctic fish species but, because of limited information on the status of many marine and freshwater species, these changes may not become evident for many years.

4.4.2.5. Essential Fish Habitat.

Summary. We have determined in the following assessment that the direct and indirect effects of implementing this alternative would have no more than minor level of effect on EFH in the Beaufort Sea. Additional leasing in the Beaufort Sea is could result in a small increase the level of seismic survey and other exploration activity, but the anticipated level of effects are the same as for Alternative 1, except that these effects may extend further into the future on new leases. Future development projects are considered speculative, but some low likelihood events, such as a large spill following new production, could have a high level of effect. A major level of effect from an oil spill to EFH does not necessarily equate to a major level of effect on salmon resources.

There are a number of past actions and ongoing activities that are potential sources of harmful effects to EFH and anticipated environmental changes that, independent of additional OCS leasing, would affect EFH well into the future. Existing leases in the project area would continue to be explored. Seismic surveys, exploratory drilling, and other ancillary activities would continue. Spills, particularly in nearshore areas or at river crossings, pose a risk to EFH. Transfer of bulk fuel to coastal communities poses the greatest risk of a large noncrude oil spill in the marine environment.

Climate change is anticipated to have a major level of effect on EFH; however, the Proposed Action is not anticipated to effect climate change. Climate change, for example, may serve to promote increased vessel traffic in the Arctic, especially in the form of tourism or cargo shipping, thereby increasing the risk of vessel accidents, groundings, and spills. The adverse effects to EFH from oil spills would depend on the timing, location, amount, type, and persistence of the oil spilled.

In the following assessment we identify the potential effects of the Proposed Action to EFH, identify the mitigation measures that could avoid or help reduce the level of these effects, and then determine the anticipated level of effect on EFH resources. These direct and indirect effects are combined with the cumulative effects from Alternative 1 (no-action alternative) to determine the new cumulative effects from implementing this alternative.

4.4.2.5.1. Potential Effects to Essential Fish Habitat. The potential effects to EFH in the Beaufort and Chukchi seas were described in Section 4.4.1.5.1 and are not repeated here.

4.4.2.5.2. Mitigation Measures. There are three primary mitigation measures that would avoid or minimize adverse effects to EFH. Stipulation 2 (Appendix F) allows seismic survey activity in the Ledyard Bay Critical Habitat Area until July 1 of each year. Any adverse effects to EFH from seismic surveys and associated vessel noise would not occur in the Ledyard Bay Critical Habitat Area after July 1. This also applies to other vessels transiting the Chukchi Sea to accomplish MMS-authorized work in the Beaufort Sea.

The remaining mitigation measures include ramping-up of seismic airguns. Ramping up conceptually allows fish to move away from a lower level of underwater noise before the noise level is increased to the

full performance range. Also, seismic operations are required to remain at least 15 mi away from other concurrent seismic operations to limit the interference with data collection. Separation of concurrent survey operations indirectly benefits fish and EFH by conceivably allowing fish to move freely between these zones of potential displacement.

4.4.2.5.3. Anticipated Effects Under Alternative 2. The following analysis describes the anticipated effects to EFH that would most likely occur if MMS opens the entire lease sale area in the Beaufort Sea without deferring any areas from consideration. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.2.5.3.1) and cumulative effects (Section 4.4.2.5.3.2).

4.4.2.5.3.1. Direct and Indirect Effects Under Alternative 2.

4.4.2.5.3.1.1. Anticipated Level of Effect from Underwater Noise. Potential effects to fish resources from anthropogenic noise and seismic-survey activity are presented in Section 4.4.1.4.1.1. Mortalities and injuries would be limited to those fish in close proximity to an operating airgun array. Ramp-up procedures would mitigate some effects by allowing fish to avoid being in close proximity to airgun array. Avoidance behavior that results in displacement from preferred habitat would be temporary. Because survey activities are limited by availability of seismic-survey vessels and similar survey resources and a limited open-water season, and are further constrained by mitigation measures that regulate concurrent surveys, the anticipated effects from this alternative would be a continuation of ongoing activities on existing Federal leases in the Beaufort Sea OCS. As a consequence, seismic surveys conducted in association with proposed Beaufort Sea Lease Sales 209 and 217 are not anticipated to have an appreciably greater level of effect than those identified for Alternative 1 (Section 4.4.1.5.3.2.1), but this effect would be extended further in time as new leases are explored and resources delineated. This activity would have no more than a minor adverse level of effect on EFH.

4.4.2.5.3.1.2. Anticipated Level of Effect from Exploration and Development. The activities that are anticipated to affect EFH include drilling and construction in marine and freshwater habitats.

Community Development. Community development is not considered to be a direct effect of the Proposed Action.

Industrial Development. Exploration and development activities that could result from the Proposed Action include potential perturbations to EFH such as noise, discharges, drilling waste, and construction activities. Effects would be localized as leases are explored and developed. Exploration and production wells, production platforms, and pipeline placement could result in a direct loss of seafloor habitats at the placement sites, but these sites are relatively small compared to the amount of similar habitats available to fish in the marine environment. Disturbed seafloor habitats likely would be reoccupied once the disturbance has abated. These activities are a continuation of ongoing activities on existing Federal leases in the Beaufort Sea OCS. As a consequence, exploration and development activities conducted in association with the proposed Beaufort Sea Lease Sales 209 and 217 would not be appreciably greater than those identified for Alternative 1 (Section 4.4.1.5.3.2.2), but these effects may be extended into the future as new leases are explored and resources delineated. These activities are anticipated to have no more than a minor level of effect on EFH.

4.4.2.5.3.1.3. Anticipated Level of Effect from Petroleum Spills. There are various aspects of important fish habitats that make them vulnerable to potential effects of a large oil spill. Young salmon use estuaries and shallow coastal waters as rearing and feeding grounds and migration areas (Costello,

Elliott, and Thiel, 2002; Elliott, 2002, citing McHugh 1967, Haedrich, 1983). Juvenile salmon EFH within the intertidal, estuarine, and nearshore zone in the Beaufort Sea would be among the areas considered more vulnerable to effects from oil-related activities. The different ways that hydrocarbons can affect juvenile salmon are detailed under Section 4.4.1.4.1.5.

It is important to remember that a large spill event associated with OCS oil and gas activities likely would occur only during the production phase, when volumes of oil or gas product is being moved to production facilities in the existing facilities at Kuparuk or Prudhoe Bay. For example, Section 4.4.1.5.3.2.3 (Petroleum Spills) describes the basis for concluding that oil or gas production resulting from the proposed lease sales is considered speculative, and production effects are not considered reasonably foreseeable. Such a commercial discovery warranting production has not been identified or proposed for development and is considered speculative at this time.

4.4.2.5.3.1.3.1. Oil-Spill Analysis. No large oil spills are assumed to occur during exploration activities. A large spill from a well blowout is described as a very unlikely event in Appendix A, Section 1.1.4. This section references the OSRA model to discuss the percent chance that a large oil spill from the Beaufort Sea lease-sale area could contact specific environmental resource areas or land segments that are have been identified as EFH (i.e., important for the spawning, rearing, or migration of salmon).

Conditional Probabilities. This section describes conditional probabilities (expressed as a percent chance) estimated by the OSRA model of a large spill contacting specific environmental resource areas or land segments (representing nearshore fish habitats). Conditional probabilities are based on the assumption that a large spill has occurred (Appendix A). Combined probabilities, in the next section, factor in the chance of one or more large spills occurring and then contacting a resource of interest. The following assessment is based on conditional probabilities. The resultant summaries recognize that models are simulations representing typical or average interactions of highly variable factors, and are used here in a broad sense in drawing conclusions about anticipated effects on EFH.

Appendix A.1 describes the many facets of oil-spill assessment pertaining to the proposed leasing actions. Maps A.1-3a through A.1-3d show the locations of the land segments dividing the Beaufort and Chukchi seas coastline for analytical purposes. The land segments and the geographic place names within the land segments are shown in Table A.1-18. Conditional probabilities of a large spill contacting any of the various land segments are reported in tables contained in Appendix A.1. There are numerous instances and probabilities whereby oil may contaminate intertidal/estuarine substrates and waters that may be used as spawning and/or rearing habitat by anadromous fish. The PAHs in weathered oil contaminating such spawning sites can be biologically available for long periods and very toxic to sensitive life stages.

Large spills are only considered following development when production starts. The fate and behavior of a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A.1). The 1,500-bbl spill would cover a smaller discontinuous area (181 km²) (Table A.1-6) than a 4,600-bbl spill (320 km²) (Table A.1-7) after 30 days. The OSRA model uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific ERAs would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed for potential effects on salmon EFH.

Approximately 40% of a 4,600-bbl spill during the open-water period would remain after 30 days, covering a discontinuous area of 320 km². If a 4,600-bbl spill reached the coastline, an estimated 49 km of coastline would be oiled. A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would

remain after 30 days, covering a discontinuous area of 252 km². An estimated 54 km of coastline could be oiled.

Summer Spill. For summer conditional probabilities, the OSRA model estimates up to a 9% chance that a large oil spill starting at LAs 1-25 contacts land segments within 30 days containing streams noted for the presence of chum salmon: LS87 (Meade River), LS94 (Fish Creek), LS95 (Colville River and Delta), LS99 (Sagavanirktok River), and LS103 (Canning River) (Table A.2-77). The model estimates up to a 7% chance of contact from PLs 1-17 (Table A.2-78). Pink salmon have been documented as being present in Fish Creek; the Meade, Colville, and Sagavanirktok rivers; and in the Staines River (LS102), Chipp River (LS87), and Ikpikpuk River (LS89) along the Beaufort Sea coast. The highest percent chance of contact is 9% for LS89 (Meade River) from LA2 within 30 days. The chance of contact for this land segment is highest, because the OSRA model's launch area and the salmon stream are in close proximity to each other (Maps A.1-3c, A.1-4). The highest percent chance of contact is 8% for LS89 (Ikpikpuk River) from PL8 within 30 days. As with the launch areas, the chance of contact with LS89 is highest, because the OSRA model's pipeline segment and the salmon stream are in close proximity to each other (Maps A.1-3c, A.1-4).

After 360 days, the OSRA model estimates that the percent chance of a large spill from LAs contacting a land segment important to pink and/or chum salmon generally increased 5% or less (Table A.2-77). The OSRA estimates that LS94 (Fish Creek) experienced the greatest increase going from 30 days to 360 days. For pipelines, the greatest increase after 360 days also occurred at LS94 (Fish Creek) which increased 3% for spills from 3 different pipelines (Table A.2-84). Other land segments, noted for the presence of salmon, generally increased <3% when comparing 30 days to 360 days.

While anadromous fish streams are relatively easy to identify, there are many other nearshore resource areas that are important to fish. For example, lagoons, river deltas, and estuaries are important to rearing fish, including outmigrating juvenile salmon. Shoreline habitats are predominantly fine-to medium-grained sand beaches or mixed sand and gravel beaches. If a large spill reached shore, it could impact an estimated 49 km of shoreline during a summer release and 54 km of shoreline as a meltout spill (winter release into/under ice) (Table A.1-7). The OSRA trajectory model predicts movement of a surface slick, but does not assess subsurface transport of oil in water or tarballs onto beaches or the persistence of oil once it has been transported to spawning beaches, rearing areas, or spawning streams.

The OSRA model estimates a large spill during summer from offshore LA8 has a 33% chance of contacting ERA86 (Harrison Bay) and a 36% chance of contacting the ERA87 (Colville River Delta) within 30 days (Appendix A, Table A.2-65). The percent chance of contact increased 2% at each environmental resource area after 360 days to 33% and 38%, respectively (Appendix A, Table A.2-71). For PL9, the OSRA model estimates a 44% chance of contact to ERA86 (Harrison Bay) within 30 days and 46% within 360 days (Table A.2-72).

Finally, because the Beaufort Sea Sales 209 and 217 area is adjacent to the Chukchi Sea, the OSRA model estimates the chance of a large spill originating in the Beaufort Sea contacting anadromous streams along the Chukchi Sea coast (LSs 40-44, 47, 49, 51, 53-60, 64, 67, 70-72, or 74) is <0.5%.

Winter Spill. For winter conditional probabilities, the OSRA model estimates a <5% chance that a large oil spill starting at LAs 1-25 contacts land segments containing streams important to anadromous fish within 30 days (Tables A.1-18 and A.2-125). Because of landfast ice along the coastline, a large spill could be prevented from contacting the shoreline at almost all locations during winter months. After 360 days, the OSRA model estimates the percent chance of contact to land segments important to chum or pink salmon increases; the chance of contact after 360 days is <12% (Tables A.1-18 and A.2-131). The

two land segments with salmon streams that have the highest percent chance of contact after 360 days are LS94 (Fish Creek), which has a 12% chance of contact from LA8, and LS103 (Canning River), which has a 9% chance of contact from LA17.

The OSRA model estimates a large spill during winter from offshore LA8 has a 22% chance of contacting ERA86 (Harrison Bay) and a 32% chance of contacting ERA87 (Colville River Delta) within 30 days (Table A.2-113). After 360 days, these percentages increase to 34% and 37%, respectively (Appendix A, Table A.2-119). Similarly, the OSRA model estimates that a large spill originating from PL9 has a 36% chance of contacting ERA86 within 30 days (Table A.2-114). The highest percent chance of contact to ERA87 is from PL10, where there is a 14% chance of contact within 30 days (Table A.2-114).

There are numerous instances and probabilities whereby oil may contaminate intertidal/estuarine substrates in waters that may be used as spawning and/or rearing habitat by pink salmon or capelin. The PAHs in weathered oil contaminating such spawning and rearing sites potentially can remain both biologically available for long periods and toxic to sensitive life stages. Lethal effects, or sublethal effects reducing growth, reproductive fitness, or overall survival, therefore, also may persist.

Combined Probabilities. Combined probabilities factor in the chance of one or more large spills occurring and then contacting a resource of interest. The OSRA model estimates the chance of one or more large spills occurring and contacting land segments with streams noted as being EFH is <0.5-5 within 30 days (Table A.3-80). The chance of one or more spills occurring and contacting ERAs 84-87 ranges from <0.5 % within 30 days over the 20-year production life of the project (Table A.3-79).

4.4.2.5.3.1.3.2. Effects from Chronic Small-Volume Spills. Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. Small or low-volume spills are defined as <1,000 bbl. The average small crude oil-spill size is 126 gal (3 bbl). An estimated 89 small crude oil spills would occur during the 20-year oil-production period (Table A.1-30), an average of more than 4 per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined-oil spills would occur during the 20-year oil-production period (Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume crude and refined oil spills would occur each year of production. It is unknown how many small-volume spills or what total volume would reach areas used by pink or chum salmon in the nearshore coastal areas. These spills would be subject to the same environmental factors that influence the trajectory analysis (currents, wind patterns, etc.). If these small-volume spills reached salmon during spawning events or incrementally harmed prey species at the same location on a recurrent basis, reproductive success and growth and survival rates for salmon could be reduced. If these spills remained unchecked and were to repeatedly reach salmon during sensitive life stages, depression of recruitment, over time, could result in reduction, displacement, or elimination of salmon from the affected area.

While small-spills are required to be reported, the number of unreported spills is unknown. Not all spills would be expected to receive a spill response. Overall, it is unclear whether, over the long-term and in the absence of a monitoring program to assess effects, any negative impacts to EFH or to salmon resources from chronic small spills would be detected.

Effects from Spill Response. Conditional probabilities do not factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Oil-spill response is assumed to have limited effectiveness (<100% of spilled oil recovered) because of the unpredictability of response time, proximity of the launch site(s) to salmon EFH, known limitations of the effectiveness of response during certain environmental conditions (such as under ice or broken ice), and the numbers of fish that could be impacted in a short period of time.

Oil-spill response could originate from Deadhorse, about 150 mi east of Barrow. Specific resource-protection activities would be employed as the situation requires and would be modified, as necessary, to meet site-specific needs. The response contractor would be expected to work with State officials on fishery-management issues in the event of a spill, including the need, for example, to boom the entrances to salmon-spawning streams and streams with important subsistence species. Effectiveness, however, could be expected to improve if spill-response equipment were staged closer to the site of a potential spill.

4.4.2.5.3.1.4. Anticipated Level of Effect from Changes in the Physical Environment. The potential for climate change to influence the physical environment and EFH in the Alaskan Arctic is described in Section 4.4.1.5.3.2.4. Widespread consumption of hydrocarbons around the world is believed responsible for climate change. The hydrocarbons consumed come from a variety of sources. Climate change already may be causing changes to EFH and to the diversity and abundance of arctic fish species but, because of limited information on the status of many marine and freshwater species, these changes may not become evident for many years. Over time, a major level of adverse effects to marine, estuarine, and freshwater EFH are likely, which will translate to effects to salmon distribution, abundance, foraging, and migrational patterns. Climate change could also benefit some salmon species by making habitat in the Arctic more hospitable for feeding, overwintering and reproduction. The degree of positive or negative effects attributable to climate change are immaterial because these changes will occur regardless of whether oil and gas development occurs in the Arctic or elsewhere in the world. Consequently, implementing the Proposed Action is anticipated to have a negligible level of direct effect on greenhouse emissions.

4.4.2.5.3.2. Cumulative Effects Under Alternative 2. Lease sales 209 and 217 likely would result in an increase in the number of leases in the Beaufort Sea OCS but, based on history, some of the leased tracts will not be explored, and some that are explored will not be subjected to further evaluation or development. Impacts to EFH from oil and gas infrastructure development on land and in State waters, unrelated to OCS activity, will continue to have a negligible to moderate level of effect. Because of the limited timing and resources available for seismic exploration and open-water exploratory drilling at active lease locations, these activities are anticipated to continue at present levels for the foreseeable future, even if more leases are issued.

The direct and indirect effects of implementing the Proposed Action, when combined with the cumulative effects from Alternative 1, are anticipated to result in a negligible to minor level of effect for seismic survey and other exploration activities, a moderate level of effect from potential future, speculative production development depending on location and other specific (currently unknown) details. Changes in the physical environment, with or without additional leasing, will likely result in a major level of effect on EFH. These effects are the same as those identified for Alternative 1.

4.4.2.6. Threatened and Endangered Species.

4.4.2.6.1. Threatened and Endangered Whales

Summary. Alternative 2 would result in negligible to minor direct, indirect and cumulative effects to ESA-listed bowhead and humpback whales and negligible effects on ESA-listed fin whales in the Proposed Action area. If the lease sales were held, effects would be negligible to minor, temporary, and

nonlethal from presence and noise of seismic surveys (2D, 3D, high resolution); vessels; aircraft; drilling and production facility placement, and operation and abandonment; petroleum spills; discharge; subsistence hunting; vessel collision and injury; and physical changes or alteration of habitat. The greatest potential for a major effect is habitat change resulting from arctic warming; effects may be beneficial or adverse, and remain speculative at this time. Direct and indirect effects of this alternative combined with the cumulative effects of Alternative 1 (No Lease Sale) result in cumulative effects from negligible to minor, the same as for Alternative 1. Mitigation applied by MMS on and adjacent to existing and new leases to potential exploration, development, and production activities avoid or minimize adverse effects to endangered whales in the Beaufort Sea. The MMS actions presumably would result in incremental increases in intensity, duration, distribution, and magnitude of activities. The total additive effect is not substantially greater than the effects of Alternative 1, and cumulative effects of this alternative remain negligible to minor.

The ESA-listed whales that can occur within or near either or both the Beaufort Sea and Chukchi Sea Planning Areas, or that potentially could be adversely affected by activities within these planning areas, are the endangered bowhead whale, fin whale, and humpback whale; however, current evidence indicates fin whales do not occur in the Beaufort Sea Planning Area.

After reviewing the current status of endangered bowhead, fin, and humpback whales, the environmental baseline for the Proposed Action area, the Proposed Action, and the cumulative effects, is NMFS's biological opinion that individual bowhead, fin, and humpback whales within the area may be adversely affected, but that the Proposed Action is not likely to jeopardize the continued existence of Western Arctic Bowhead whales, North Pacific fin whales, or humpback whales. No critical habitat has been designated for these species: therefore, none will be affected. The NMFS concludes at this time that there is a reasonable likelihood that oil and gas development and production in the Alaska Beaufort and Chukchi seas, as described, would not violate Section 7(a)(2) of the ESA (NMFS, 2008c).

The following analysis describes potential adverse effects to endangered whales from OCS activities associated with oil and gas exploration and development activities, as described in Section 2.4.4, Scenario for the "Typical" Beaufort Sea Lease Sale (Sales 209 and 217); potential effects in Section 4.4.1.6.1.1; mitigation measures to avoid or minimize potential adverse effects to endangered whales in Section 4.4.1.6.1.2, and the anticipated effects resulting from application of mitigation to potential adverse effects in Section 4.4.1.6.1.3. Anticipated effects discussed herein consider mitigation measures applied to determine the effects of Alternative 2, the Proposed Action, on bowhead, fin, and humpback whales.

4.4.2.6.1.1. Potential Effects to Threatened and Endangered Whales. Potential effects to endangered whales were described in Section 4.4.1.6.1.1 and apply to activities identified in Alternative 2, the Proposed Action, that could occur if the entire Beaufort Sea Planning Area would be open to proposed Lease Sales 209 and 217. Potential effects described in Section 4.4.1.6.1.1 remain similar for all alternatives, including the Proposed Action, and are not repeated here.

4.4.2.6.1.2. Mitigation Measures. The mitigation measures listed in Section 4.4.1.6.1.2 are in effect for existing OCS activities to protect ESA-listed whales and other marine mammals during federally permitted seismic and exploratory drilling in the Beaufort and Chukchi seas. It is anticipated these mitigation measures would be implemented in future activities associated with Lease Sale 209 and 217, as appropriate. The Federal measures represent current Federal regulation; the collective results of recent MMS Section 7 consultations for lease sales (2008 Regional Biological Opinion (ARBO); Lease Sales 193, 186, 195 and 202); and programmatic seismic activities in the Beaufort and Chukchi seas. Mitigation of specific exploration plans (EPs), development and production plans (DPPs), geological and geophysical permits (G&G) would be based on complete application packages that meet information

needs identified in the NTLs for MMS and NMFS to assess case by case and determine appropriate adaptive mitigation.

In addition to the mitigation measures listed in Section 4.4.1.6.1.2, measures are provided here to address the dynamic management of the synergistic effects and interrelationships of multiple authorized OCS actions, both mobile and stationary, that may occur simultaneously and in proximity to one another.

- Adapt an organization for in-season, onsite, day-to-day, open-water season administration and management. Such a command system provides a structured team for day-to-day onsite centralized planning; decision making; conflict avoidance and resolution; coordination; mitigation implementation; dispatch; operational tracking; personnel and equipment resources coordination; real-time intelligence (coordinated data input for location, type, monitoring data for all activities, vessels); communications; record keeping; and consistent data management. This is similar to command systems that integrate regulatory, industry, local government, stakeholder, and other entities on a short-term basis (open-water period) and are delegated decision making command authority. If activities become more or less complex over time, the command team can change to an appropriate level and composition of skills. An analogy might be the function of a flight control tower at an airport. This is a proven and flexible system or organizational approach to complex and controversial operations as experienced in the Arctic OCS.
- Unitized or preseason comprehensive or collective planning for all seismic-survey and other OCS activities for each open-water period.

The following is a summary of generalized practices available to mitigate effects to endangered whales relative to the specific location, type, duration, magnitude, complexity, and timing of an activity being applied for (may or may not be currently active in the Alaska OCS):

- Minimum altitude for aircraft overflights of marine mammals: 1,000-ft (460 m) minimum above-ground level (AGL) while conducting monitoring flights and personnel transport to offshore facilities - all aircraft.
- Seasonal operation windows; examples: no seismic-survey activity until after July 1 in the spring lead system, to protect concentrated migrating and calving bowhead whales.
- Spatial and temporal closures to ensure migrating bowhead whales to access and occupy traditional subsistence-hunt areas to provide historical opportunity for spring and fall harvest.
- Sound-verification tests to determine individual sound-proliferation profiles for specific sound sources.
- Situational shutdown protocols when marine mammals occur within established sound-exposure level safety zones of injury and behavior.
- Established sound-level criteria for injury, and onset of significant behavior responses.
- Laws-regulation; example: 100-yd (91.5 m) approach distance and slow, safe speed regulation for humpback-vessel interactions; ESA and MMPA compliance, and respective Letters of Authorization and IHA procedures.
- Application of NOAA-established vessel-large whale approach and interaction guidelines or establish appropriate guidelines for OCS activities.
- Spill-response preparedness, protocols, and standard practices for prevention cleanup response.
- Conflict Avoidance Agreements.
- Establish minimum distances between and arrangements of other OCS sound sources (active drillships) that allow for corridors with adequate noise levels to allow free passage of migrating marine mammals.
- Protect opportunity for timely marine mammal access and occupancy duration to traditional subsistence-hunting areas.

- Communication-network systems.
- Monitoring and research programs designed to implement and evaluate effectiveness of mitigation and to provide information to craft more effective mitigation and make better decisions to protect endangered species while meeting the goals of the OCS Program. Passive-acoustic monitoring and active-acoustic monitoring are examples as well as aerial- and vessel-marine mammal monitoring of exclusion and safety zones around sound-source vessels. To document and confirm new occurrences of and identify trends in distribution, abundance, and habitat selection of endangered whales and their responses, short and long term, to activities.
- Monitoring to have real-time data from which to make timely, proactive, in-season decisions to eliminate and minimize potential conflicts and adverse effects.
- Research to resolve specific issues and adverse effects to endangered whales where data are lacking, or specific information needs to better implement operations and mitigation actions. Satellite-transmitter equipped whale tracking during migrations and habitat selection determination studies; photo-identification to strengthen stock of origin for humpback whales.

4.4.2.6.1.3. Anticipated Effects Under Alternative 2. The following analysis describes the anticipated effects on endangered whales that likely would occur if MMS opens the Beaufort Sea Planning Area (no deferral areas) to Lease Sales 209 and 217 noted in the Proposed Action. Anticipated effects discussed herein consider mitigation measures and specific biological and activity characteristics discussed in Sections 4.4.1.6.1.2 and 4.4.2.6.1.2.

4.4.2.6.1.3.1. Anticipated Effects from Seismic-Survey Noise.

Effects from 2D/3D/4D Seismic-Survey-Related Noise and Disturbance. It is expected that prospective leaseholders and others would conduct 2D/3D/4D seismic surveys to evaluate potential lease blocks for oil and gas resources in Beaufort Sea Planning Area prior to and after Lease Sales 209 and 217. These surveys would occur during the open-water period, and noise introduced to the marine environment by such surveys is anticipated potentially to injure, disturb, or modify behavior of bowhead and humpback whales during important seasonal migrations, feeding-concentration periods, and locations. The 2D/3D/4D seismic activities would be subject to mitigation measures, terms, and conditions of IHAs issued by NMFS, and MMS mitigation measures determined through ESA Section 7 consultation and subsequent Biological Opinion to avoid or minimize effects such that anticipated adverse effects to endangered whales are negligible to populations and may result in minor, temporary and nonlethal effects to some individual whales.

Effects of Noise from High-Resolution Seismic Surveys. It is expected that leaseholders and others would conduct high-resolution seismic surveys to evaluate and support oil and gas exploration drilling, delineation, and production on leases obtained from Lease Sales 209 and 217. If potential commercial deposits are indicated, localized high-resolution seismic surveys would be expected to increase as leaseholders evaluate and plan specific exploration, delineation, and production actions. High-resolution surveys would be expected to decline in localized areas as production and transport facilities are completed. High-resolution seismic activities would be subject to mitigation measures, terms, and conditions of IHAs issued by NMFS and MMS mitigation measures determined through ESA Section 7 consultation and subsequent Biological Opinion to avoid or minimize effects such that anticipated adverse effects to endangered whales are negligible.

4.4.2.6.1.3.2. Anticipated Effects from Vessel and Aircraft Traffic and Noise.

Effects of Noise from Icebreakers. Icebreakers introduce noise levels to the marine environment at greater levels than vessels not engaged with the high-intensity power needed for ice management. Bowhead whales would be most sensitive to icebreaker activity, as fin and humpback whales are not likely to be in ice-covered waters. Bowhead whale response to icebreaker noise usually is avoidance. Increased numbers of icebreakers and over an expanding region of activity could expose more whales to more frequent short-term exposure to noise potentially earlier and later in the ice-associated period of the year. Drillships often are attended by an icebreaker in the late fall as ice forms and assists in prolonging the drilling period. This trend is anticipated to continue into the foreseeable future to support Beaufort Sea drillship operations for exploration and delineation wells. If resource discoveries on Lease Sales 209 and 217 leases are developed (speculative at this time), icebreaker support for platform construction and production would occur in deeper water where drillships would be used. These vessels would be relatively free to operate in areas where disturbance to concentrations of migrating bowhead cows and newborn calves could occur in the spring lead system, and in early winter as ice forms and the fall bowhead migration is occurring. Icebreaker activities would be subject to mitigation measures, terms, and conditions of IHAs issued by NMFS and MMS mitigation measures determined through ESA Section 7 consultation and subsequent Biological Opinion to avoid or minimize effects such that anticipated adverse effects to endangered whales are negligible. Some individual whales potentially could experience minor, temporary, nonlethal avoidance and alteration of migratory path, and they may be exposed more than one time to icebreaker noise during a single migration period.

Effects of Noise from Other Vessel Traffic. Vessel-related postlease activities likely would increase incrementally in the Beaufort Sea, and activity potentially could take place in lease blocks that have not experienced exploration-drilling activities in the past. Support vessels and barges would make multiple trips to West Dock and offshore activities. Bowhead and humpback whales would experience temporary, nonlethal avoidance-behavior responses to vessel traffic and noise. The MMS-imposed mitigation measures on vessels associated with oil and gas exploration and development activities would avoid or minimize effects to endangered whales. As a result, MMS-authorized vessel activity would have proportionately fewer impacts to endangered whales than unrestricted vessel operations. Noise and movement of the Proposed Action OCS authorized vessel-related effects are anticipated to be negligible, temporary, and nonlethal.

Anticipated effects could result in the injury or mortality of individual bowhead and humpback whales in the Beaufort Sea as result of vessel-whale contact, including collision and engaged propeller injury. Regulations and guidelines relating to vessel-whale interaction would serve to mitigate such effects when visibility is good and active observer monitoring is conducted; however, during darkness, poor visibility due to weather, and ocean state, the opportunity exists for vessel-related injury or mortality. The MMS-imposed mitigation measures would serve to minimize such injury or mortality, and no injury or mortality of large whales related to oil and gas vessel contact has been documented in the OCS Arctic Region. Injury and mortality from vessel-whale contact could occur but is not anticipated.

Effects of Noise from Aircraft Traffic. Helicopter support for postlease operations is expected to increase as exploration, development, and production phases occur on the Beaufort Sea leases resulting from Lease Sales 209 and 217. Crew change and light supply helicopter overflights are anticipated to support exploration activities. In the Beaufort, fixed-wing aircraft used as a monitoring platform is anticipated to continue at present levels, and may be active in areas of the Beaufort where such activities have not occurred in the past. The MMS-required mitigation avoids or minimizes the effects of aircraft traffic and noise to endangered whales and other marine mammals; however, flight altitude restrictions may be violated to ensure the safety of personnel and flight operations when adverse flight conditions

occur. The MMS acknowledges there may be incremental increases in numbers and duration of time such flights would occur for production-related support, crew transport, and monitoring flights if development (speculative at this time) should occur. However, mitigation measures minimize adverse effects from MMS aircraft activity. Fixed-wing monitoring activities would not occur under adverse weather, visibility, or sea conditions and would be subject to altitude mitigation standards to avoid effects to endangered whales. Minor, temporary, nonlethal effects are anticipated from aircraft traffic and noise.

4.4.2.6.1.3.3. Anticipated Effects of Noise from Drilling Operations (placement, construction, drilling). Drilling on OCS leases is anticipated as leaseholders explore potential productive oil and gas finds. Exploration drilling likely would involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible if development and production is pursued. If exploration drilling indicates development and production is feasible, drilling would be expected to continue at a rate determined by the number of drill rigs available.

For exploration drilling, up to two drillships are anticipated to be operating simultaneously in the Beaufort Sea. These may drill at more than a single location in a given year. There are no drillships currently active in the Beaufort OCS; however, drilling has occurred there in the past. Bowhead whale response to stationary sound sources indicates avoidance and behavioral modification that includes altering travel path or deflecting slightly around drill operations. Little is known about humpback whale response to stationary sound sources. Humpback and bowhead whales are not present during winter when ice cover predominates. Bowhead whales may be exposed to drilling-related activities conducted in spring during the whales' spring migration through the Beaufort Sea lead system if drilling activities are located near enough and produce sufficient noise levels to cause avoidance responses by the whales. Similarly, fall migrating whales could be exposed to the noise introduced to the marine environment, and avoidance response would be anticipated. Drillship operations, drill location, platform placement and construction, and support activities are subject to MMS' mitigation measures that avoid or eliminate adverse effects to endangered bowhead whales. Effects of drillship operations can cause slight deflection of some migrating whales from established migration corridors; however, the deflection is transitory and migration-corridor fidelity is reestablished after passage of a drillship or platform after an avoidance deflection occurs. The MMS would impose mitigation measures to avoid deflecting migrating whales away from and provide for historical levels of whale access to and presence within subsistence-hunting areas during hunting periods, when drillship location is east of subsistence-hunting areas, to avoid impacts to subsistence-harvest opportunity. Similar mitigation would be applied should delineation and production wells be drilled. Synergistic adverse effects as a result of platform placement and construction, drilling, and other concurrent activities are avoided or minimized by application of mitigation measures that avoid or minimize the footprint of multiple activities relative one another and to the bowhead whale and other endangered whale biological activities, movement, and subsistence hunts.

Subsistence-harvest opportunity is not anticipated to be enhanced or hindered by noise from drilling activities. Localized prey concentrations, in part, may be locally avoided by some whales when in close proximity to active drilling operations; however, bowhead whales appear to be more likely to tolerate sound when motivated to feed in such areas. Similar toleration responses of humpback and fin whales under similar circumstances are uncertain. It is unknown whether tolerating higher level sound exposure in high-concentration feeding areas results in TTS (no tissue damage, but temporary reduction in hearing sensitivity) or PTS (resulting in tissue damage and permanent loss of hearing sensitivity). Some individuals could experience TTS or PTS, but it is uncertain at this time. No population-level effects and minor, temporary, nonlethal effects are anticipated, with the exception of authorized subsistence harvest, which is anticipated to remain at current levels.

4.4.2.6.1.3.4. Anticipated Effects of Noise from Production. It is speculative at this time as to whether development and production would occur on leases from Lease Sales 209 and 217, but it is anticipated that development and production of economically recoverable resource discoveries likely would occur. Effects of noise on endangered whales in the Beaufort Sea Planning Area that could result from seismic, vessel, aircraft, and drilling activities associated with development and production were discussed in Sections 4.4.2.6.1.3.1 through 3 above. Development and production plans would be subject to ESA Section 7 consultation, as appropriate. Mitigation measures that ensure negligible effects to endangered whale species would be imposed by MMS, and specific IHA mitigation measures, terms, and conditions would be applied by NMFS. Development and production would entail a suite of ancillary activities; product transportation; infrastructure construction and maintenance; platform construction and maintenance; drilling; product gathering, production and processing; support vessel and aircraft for personnel, supply, and maintenance that would continue over the duration of production. Minor, temporary, nonlethal effects to some individual endangered whales are anticipated. Detectable population-level effects on bowhead, humpback, and fin whales are not anticipated.

4.4.2.6.1.3.5. Anticipated Effects of Noise from Facility Abandonment Activities.

Abandonment activities would occur when a production facility is no longer capable of commercial production. Abandonment activities and associated noise are anticipated to be localized and short term; however, it is speculative to anticipate the degree to which facilities may be abandoned and/or used for other industrial, civilian, or military purposes. Localized exposure of some individual whales to noise introduced to the marine environment from abandonment activities could occur. Activities could include vessel and barge traffic and noise; aircraft support traffic and noise; use of explosives for demolition; and possibly noise and activities associated with refurbishing facilities for other industrial, civilian, or military uses not associated with OCS oil and gas. Eventually, OCS production facilities and infrastructure would be abandoned. The MMS would require mitigation measures, as appropriate, to avoid or minimize effects to endangered whales and the subsistence hunt for bowhead whales on OCS leases. Minor, temporary, nonlethal effects to some individual endangered whales are anticipated.

4.4.2.6.1.3.6. Anticipated Effect of Noise from Petroleum-Spill-Cleanup Activities. In the event of a large petroleum spill in the Beaufort Sea, it is reasonable to expect emergency response and cleanup activities that would involve aircraft and vessel deployment. Refer to Section 4.4.1.6.1.1.4 and 4.4.1.6.1.3.3.2 for discussion of potential and anticipated impacts to endangered whales from vessel and aircraft traffic and noise. The general avoidance response of bowhead whales to active vessels and low-flying aircraft would serve to buffer whale contact with a spill, especially in the spring lead system and if it were fresh oil with high concentrations of volatile aromatic hydrocarbons, which potentially would be injurious or fatal to bowhead whale cows and very young calves. It is anticipated that, depending upon the location, timing, and circumstances of a spill, delayed spring bowhead migration and route alteration could occur for some whales. Much of the spring lead system in the Beaufort Sea is offshore of existing leases and sources of fresh spilled petroleum. Endangered whale avoidance of noise from spill-cleanup vessels, aircraft, and human activity in the open-water season would serve to decrease contact opportunity and shorten the duration of exposure to oil and poor air quality resulting from volatile toxic aromatic hydrocarbons (benzene, xylene, toluene, and PAHs) associated with spilled petroleum. Noise and activity could alter use or displace whales from preferred habitats or prey concentrations. Minor, temporary, nonlethal effects are anticipated from petroleum-spill response and cleanup activities. Some individuals could experience impaired lung and other physiological function or mortality if prolonged exposure to polluted air occurs.

4.4.2.6.1.3.7. Anticipated Effect from Discharges. Discharges related to exploratory drilling would occur and, if released into the marine environment, effects would remain localized in relation to affecting endangered whale habitat and prey populations. The effects of such discharges are anticipated

to remain localized as a result of rapid deposition and dilution and potentially contaminate (if toxic contaminants are present in discharges) an extremely small proportion of the habitat or the prey base available to endangered whales. Such effects would be negligible in terms of population-level effects. Contaminants and discharges are regulated by other agencies, and levels that would contaminate marine mammals are prohibited. Bowhead whales are long lived, and a few individuals potentially could accumulate contaminants; however, bowhead whale tissue sampled to date indicate contaminant accumulation is not an issue in the current bowhead whale population but do indicate long monitoring to be conducted to detect any change over time. Bottom-founded drilling units or gravel islands may inundate small areas of benthic habitat and seafloor that support epibenthic invertebrates bowheads and other endangered whales use as food. Such effects would be negligible in relation to the available habitat in the Beaufort Sea. Turbidity or sediment suspension in marine waters would remain localized to the immediate area of gravel island construction, placement of fill, and installation of gravel bags or sheetpile, and they are not anticipated to affect bowhead whales. The proportion of habitat and prey affected is negligible compared to the habitat that would be available. Some construction activities likely would occur in winter and in the open-water period before the fall migration would occur. The MMS mitigation measures likely would require no discharges into marine waters but that they be treated and disposed of into the subsurface in disposal wells or barged to and disposed of in designated and approved disposal wells. Anticipated effects on fin and humpback whales are uncertain and assumed to be similar to the anticipated effects on bowhead whales. Negligible effects from discharges are anticipated.

4.4.2.6.1.3.8. Anticipated Effects from Large and Small Petroleum Spills on Endangered Bowhead, Humpback, and Fin Whales. Potential effects of petroleum spills on endangered whales are discussed in Section 4.4.1.6.1.1.1.1. Fresh oil spills with high content of volatile aromatic hydrocarbons into marine waters associated with the spring lead system and the large numbers of bowhead whales migrating through the lead system present the greatest potential to affect large numbers of bowhead whales and vulnerable newborn calves. Exposure to a large spill of fresh oil in summer or fall areas where prey concentrations have concentrated feeding whales also presents the potential to affect large numbers of whales.

No large petroleum spills are anticipated from exploration activities (Appendix A, Section 1.1.4). A large spill from a well blowout is considered a very unlikely event. Development/production projects and associated infrastructure for product transport may occur on potential leases in the Beaufort Sea OCS. The combined probabilities (expressed as percent chance) of one or more large spills ($\geq 1,000$ bbl) occurring from any launch areas of pipelines and contacting environmental resource areas important to endangered whales (Table A.1-15) varies from <0.5 - 3.0% over the production life of the project within 180 days (Table A.2-157). In the unlikely event of a large oil spill, some individual bowhead whales may experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, the number affected likely would be small. Some individual whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Anticipated effects of exposure of whales to spilled oil may result in lethal effects to some individuals, and most individuals exposed to spilled oil likely would experience temporary, nonlethal effects that may cause temporary or permanent impairment of physiological functions and potential productivity. Although very unlikely, a spill event resulting in fresh oil with high aromatic hydrocarbon release and retention in the atmosphere near the surface in the spring lead system, at a time and place where large numbers of bowhead whales are present and confined to the lead system, could cause prolonged exposure of whales to inhalation of aromatic hydrocarbons. This would have moderate to major effects, including mortality of large numbers of newborn calves of the year and other individuals. Prolonged exposure of large numbers of feeding bowhead whales or small numbers of humpback whales concentrated in high prey density could be exposed to prolonged oil contact

and experience moderate effects, including mortality of some individuals and impaired physiological function and reproductive capacity. Both latter cases are considered very unlikely; however, if they should occur, they could result in long-term adverse population-level effects.

4.4.2.6.1.3.8.1. Vulnerability of Whales to Oil Spills. Fin whales are not expected to occur in the Beaufort Sea anytime of the year. Humpback whales have been observed only in the ice-free period of the year on one occasion in western Harrison Bay of the Alaska Beaufort Sea, and some individuals potentially would be vulnerable to contact from summer-spill events. Bowhead whales migrate and give birth to some calves in late winter and early spring in the Beaufort spring lead system and migrate and, to a varying degree between years, concentrate in large numbers for fall feeding activities where areas of prey concentrations occur. In some years, bowheads remain dispersed and large feeding aggregations do not occur; however, the known fall migration corridor is relatively consistent from year to year in the areas where monitoring has been conducted over the past decades. Timing of ice formation appears to be a major factor influencing variation in the migration-corridor distance offshore from year to year. Effects on bowhead whales associated with an oil spill is likely to reflect seasonal habitat use; age structure, and proportion of population contacted; and situational variables surrounding the spill itself.

4.4.2.6.1.3.8.2. Oil-Spill Analysis. The potential for large spills to contact whale species in the Beaufort Sea was described in the Beaufort Sea multiple-sale EIS (USDOJ, MMS 2003a.). Adjustments in the environmental resource area polygons (size/shape) and other model refinements have updated the assessment for the proposed Beaufort Sea lease sales discussion below. The results of this analysis are similar to those for the previous multiple lease sales in the Beaufort Sea. The percent chance of a large oil spill contacting an environmental resource area or habitat important to endangered whales is not the same as chance of oil contacting whales. Effects of oil contacting whales must consider/verify that whales are present; whale-oil contact occurs; duration of contact; age of spilled oil; atmospheric mixing and other variable circumstances of a specific spill event; and location, movement, avoidance capability/opportunity, numbers, age classes, and activity of whales.

The spill rate of large platform and pipeline spills during production is 0.58 (95% confidence interval = 0.26-0.78) per billion barrels with a 26% chance of one or more large spills occurring over the 20-year life of the project (Appendix A, Table A.1-26). For the development and production phases, the fate and behavior of a 1,500-bbl spill from a platform and a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller area (181 km²) (Appendix A, Table A.1-6) than a 4,600-bbl spill (320 km²) (Appendix A, Table A.1-7) after 30 days. The OSRA model uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific environmental resource areas would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed from this point on. At some point in time, natural gas may become the primary product produced in the Beaufort Sea. The probabilities of contact with environmental resource areas would be considered considerably less, as the natural gas liquids and volatile component would age, evaporate, and disperse into the atmosphere much more rapidly than crude oil (Table A.1-10). The prolonged exposure of whales to volatile aromatic hydrocarbons could occur but is unlikely with the degree of atmospheric mixing that occurs in the Beaufort Sea area, and such a spill would age and dissipate to a much greater degree than oil, and disperse into the atmosphere and not remain on the water surface for a long period. Prolonged periods of calm that would allow the heavier and toxic components of gas to remain concentrated at or near the ocean surface are unlikely.

A 4,600-bbl spill could contact environmental resource areas where bowhead and humpback whales may be present (Appendix A). Approximately 40% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in the fall or under ice in the winter would melt out in the following summer. Approximately 69% of a 4,600-bbl

spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km².

The following discussion presents conditional and combined probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting or occurring and contacting environmental resource areas important to bowhead, humpback and/or fin whales. Conditional probabilities are based on the assumption that a large spill has occurred (see Appendix A). Combined probabilities factor in the chance of one or more large spills occurring and then contacting. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the environmental resource areas discussed. The environmental resource area references and locations important to bowhead and humpback whales in the Beaufort Sea are found in Appendix A, Table A.1-15 and Maps A.1-2a through 2e and the launch areas and pipeline segments are found in Appendix A, Map A.1-4 (Beaufort Sea).

Conditional Probabilities-Large Spills. This section discusses the chance that a large oil spill, assuming one occurs, from the Beaufort Sea Lease-Sale area could contact specific environmental resource areas that are important to bowhead and humpback whales.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting bowhead, fin and humpbacks seasonal habitats (Table A.1-15)). Conditional probabilities are based on the assumption that a large spill occurred (see definition and applications, Appendix A).

Summer Spill. The following discussion summarizes LAs 1-25 and PLs 1-17 during summer, unless otherwise specified. The OSRA model estimates that the chance of a large spill originating from LAs 1-25 contacting environmental resource areas important to endangered whales (Table A.1-15) within 10 days ranges from <0.5-27% (Table A.2-63) and from <0.5-35% from PLs 1-17 (Table A.2-64), depending on the distance between the resource areas and the source of the spill (Maps A.1-4 and A.1-2a through e).

The OSRA model estimates that the chance of a large spill contacting any offshore resource areas important to endangered whales within 30 days ranges from <0.5-33% from LAs 1-25 (Table A.2-65) and from <0.5-39% from PLs 1-17 (Table A.2-66), depending on the distance between the resource area and the source of the spill (Maps A.1-4 and A.1-2a through e).

The OSRA model estimates that the chance of a large oil spill contacting any offshore resource area important to endangered whales (Table A.1-15) within 180 days ranges from <0.5-35% from LAs 1-25 (Table A.2-69) and from <0.5-41% from PLs 1-17 (Table A.2-70), depending on the distance between launch points/pipelines and resource areas (Maps A.1-4 and A.1-2a through e).

The highest chance of contact from launch areas occurs to ERA32 (Ice/Sea Segment 4) along the fall migration corridor for bowhead whales, which has a 33% chance of contact from LA10 within 180 days (Table A.2-69). The chance of contact to this environmental resource area is highest, because the OSRA model's launch area and the resource area are in close proximity to or overlap each other. The OSRA model estimates that LAs 8-13 have a 13-19% chance of contacting ERA32 (Table A.2-69). The highest percent chance of contact from pipeline segments is from PL4 to ERA32 (Harrison Bay), which has a 41% chance of contact within 180 days (Table A.2-70). As with the launch areas, the chance of contact in this environmental resource area is highest, because the pipeline segments and the resource area are in close proximity to or overlap each other.

Bowhead whales in the process of calving and accompanied by newborn calves are somewhat confined to the Chukchi spring lead system, ERA19, during the spring migration period (April-June). The highest

chance of contacting ERA19 is <0.5% from any launch area within the Beaufort Sea within 180 days (Table A.2-69). Similarly, a spill originating from any pipeline segment has a <0.5% chance of contacting bowhead whales using ERA19 within 180 days (Table A.2-70). Similarly, bowheads continue the spring migration into the Beaufort spring lead system (ERAs 24, 25, 26, 27, 28, 37, and 80). For ERAs 24-28, 37, and 80, the OSRA model estimates the chance of a large oil spill contacting within 180 days from LAs 1-25 is <0.5-6% and <0.5-1 for PLs 1-17 (Tables A.2-69 and 70). The pipeline segments used for the OSRA analysis lie inshore of these environmental resource areas, and prevailing winds, currents, and ice in the area would move oil toward shore.

The OSRA model estimates the chance of a large spill contacting ERAs 65, 20-22, and 29-35 from any launch area is <0.5-35% (Table A.2-69). The OSRA model estimates the chance of oil contacting these resource areas ranges from <0.5-41% from pipeline segments within 180 days. The potential for prolonged exposure of migrating bowhead whales to fresh (<10-day old oil) is not likely, as migrating whales would rapidly transit through a spill area; however, if migrating whales delay or concentrate to feed in a spill area, prolonged exposure could occur. Some whales could experience physiological function impairment and possible mortality from inhalation of aromatic hydrocarbons; however, numbers affected are likely to be small.

Winter Spill. The following discussion summarizes LAs 1-25 and PLs 1-17 during winter, unless otherwise specified. The OSRA model estimates a <0.5-22% chance that a large spill originating at LAs 1-25 would contact environmental resource areas important to endangered whales within 10 days, and a <0.5-27% from PLs 1-17 (Appendix A, Table A.2-111 and A.2-112). The highest chance of contact from a pipeline segment occurs from PL1 to ERA25 (Beaufort Spring Lead 7), which has a 27% chance of contact within 10 days (Appendix A, Table A.2-112). The highest chance of contact is from a launch area occurs from LA1 to ERA24 (Beaufort Spring Lead 6), which has a 22% chance of contact within 10 days (Appendix A, Table A.2-111). The chance that a spill originating from LAs 1-6 contacting ERA24 is within a range of 1-10%. The chance of contact tends to be highest where the launch areas or pipeline segments and the resource area are in close proximity to or overlap each other (Appendix A, Table A.2-111 and A.2-112, maps).

The OSRA model estimates that a <0.5-30% chance that a large spill originating at LAs 1-25 would contact resource areas important to endangered whales within 30 days during the winter and <0.5-27% from PLs 1-17 (Appendix A, Table A.2-113 and A.2-114). The highest chance of contact from a pipeline segment is from PL1 to ERA25 (Beaufort Spring Lead 7), which has a 27% chance of contact within 30 days. The highest percent chance of contact from a launch area is from LA7 to ERA28 (Beaufort Spring Lead 6), which has a 30% chance of contact within 30 days (Appendix A, Table A.2-113). The chance that a spill originating from adjacent LAs 5-10 would contact ERA28 range from 9-23%. The chance of contact tends to be highest where the OSRA model's launch areas or pipeline segments and the environmental resource area are in close proximity to or overlap each other (Appendix A, Table A.2-113 and A.2-114, maps).

The OSRA model estimates a <0.5-31% chance that a large spill originating at LAs 1-25 would contact resource areas important to endangered whales within 180 days during the winter, and a <0.5-31%, from PLs 1-17 (Appendix A, Table A.2-117 and A.2-118). The highest percent chance of contact is from a pipeline segment to ERA25 (Beaufort Spring Lead 7), which has a 31% chance of contact within 180 days. The highest chance of a contact from a launch area is from LA7 to ERA28 (Beaufort Spring Lead 10) (Appendix A, Table A.2-117). The chance that a spill originating from adjacent LAs 5-10 would contact this same ERA range from 13-24%. The chance of contact tends to be highest where the OSRA model's launch areas, pipeline segments, and the environmental resource area are in close proximity to or overlap each other (Appendix A, Table A.2-117 and A.2-118, maps).

In the Chukchi Sea spring lead system, where spring bowhead migration and calving take place (ERA 19), the of contact is <0.5-1% within 3 days and <0.5-5% within 10 days of a winter spill from any Beaufort Sea launch area or pipeline segment. Inhalation of volatile aromatic hydrocarbon components of fresh oil presents the potential for nonlethal, temporary, short-term and long-term impairment of physiological function and mortality of newborn calves and whales concentrated in the Beaufort or Chukchi spring lead systems. Winter spills can be trapped under and within ice and be transported to environmental resource areas within and under ice to be released as ice movement mixes and exposes trapped oil, melts, or breaks up in the spring. The freshness or aging of fresh oil trapped or incorporated into ice in regard to volatile aromatic hydrocarbons can vary depending on pathways for exposure and opportunity to dissipate into the atmosphere. The OSRA model estimates a winter spill has a <0.5-31% of contacting spring lead system environmental resource areas from any launch areas or pipeline segments within 180 days. A large spill melting out in the spring still could retain characteristics of fresh oil, including varying amounts of toxic aromatics.

If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

Combined Probabilities-Large Spills. Combined probabilities differ from conditional probabilities in that they do not assume that a spill has occurred and consolidate nonuniform weighting of launch probabilities into one unit probability. The chance of one or more large spills occurring is multiplied by the areawide chance that a large spill would contact a particular environmental resource area to estimate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3). The combined probabilities (expressed as percent chance) of one or more large spills (>1,000 bbl) occurring from any source in the Beaufort Sea lease-sale area and contacting resource areas important to endangered whales varies from <0.5-3% within 180 days over the 20-year production life of the project (Table A.2-157).

Chronic Low-Volume Spills. Small or low-volume spills are defined as being <1,000 bbl. The average crude-oil spill size is 3 bbl for spills <500 bbl. An estimated 89 small crude oil spills would occur during the 20-year production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average refined oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined oil spills would occur during the 20-year production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur in each of 20 years of production.

It is unknown how many small-volume spills or what total volume would reach areas used by endangered whales. Vessel and aircraft traffic, noise, and human activity associated with oil-spill response and cleanup is anticipated to result in avoidance responses from endangered whales and reduce the opportunity for whales to contact these spills. Negligible, temporary, nonlethal effects are anticipated from low-volume spills.

Spill-Response Activities. The conditional or combined probabilities do not consider the effectiveness of oil-spill response activities to large spills, which vary from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Activities purposely stimulating an avoidance response to deflect whales away from or around spilled oil or cleanup operations and other human activities (large numbers of cleanup workers, boats, and additional aircraft) could impact endangered bowhead whales if large numbers of migrants, especially females with newborn calves, are confined to the spring lead system. Such activities may have limited success,

depending on whales' opportunity, ability, and inclination to avoid the activity, delay migration, or detour around a spill. The avoidance effect of cleanup activity or actively out of ice leads that oil is expected to enter may be counterproductive, because there may be few effective alternative routes in the lead system available for whales, especially calves that cannot break through ice up to 18 inches thick to breathe and require shorter distances between more frequent breaths than adults. Failure of calves to effectively follow mothers through large areas of ice cover could result in enhanced calf mortality that could exceed, for the year of the spill event, the Potential Biological Removal established for the bowhead population recovery. Calf losses of this magnitude would affect recruitment of reproductive females into the population when this cohort would enter the productive segment of the population and, thereby, contribute to potential decline in productivity at a population level over what would have been their effective productive lifespan. Anticipated effects from cleanup activities in leads during April-June are anticipated to be temporary and nonlethal; however, some bowhead whales, especially newborn calves, under some circumstances could experience moderate or major effect level and mortality. Cleanup activity in the open-water period is anticipated to result in negligible effects to endangered bowhead, humpback, or fin whales, because the tendency and opportunity to avoid activity would not be hindered by ice conditions. Some displacement from high-value feeding habitats could occur for an entire season, depending on the circumstances of a specific spill event, whether a spill occurs, and that an area important to whales is affected when they are present.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with NMFS regarding whale-management activities in the event of a spill. In an actual spill, NMFS likely would be active within the Incident Command organization to review and approve proposed activities and monitor their effects. As a member of the team, NMFS personnel largely would be responsible for providing critical information affecting response activities to protect endangered whales.

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce temporarily the ability to effectively use food and contribute to long-term contamination of endangered whale tissues. This generally is not likely to affect a large proportion of populations, because a localized event would contaminate a small portion of the annual and lifelong prey intake of an individual whale and the large region where prey is available to endangered whales. The contamination of some local habitat areas is not likely to affect a large proportion of the population, because they are likely to have access to alternative prey and feeding areas that is widely distributed in the region.

Summary of Spill Effects. To put the chance of a large spill having population-level impacts in perspective, one must consider several variables. First, for an oil spill to occur, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find ranged from 17-50%, indicating that production is unlikely (USDOJ, MMS 2003a). Second, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach environmental resource areas important to endangered whale species, if and when the whales are present or, in the case of a winter spill, when migrating whales return. Finally, the number, sex/age, of the whales and the duration and type of exposure to whales would have variable degrees of effects, from negligible, temporary, nonlethal effect to major mortality events having long-term population-level effect. Given the stated low chance of successful oil field development, the low likelihood that a large spill would occur, and the low percent chance that a large spill would reach resource areas important to endangered whales, including those areas with migrating and calving bowhead whales concentrated in the spring lead system, a spill causing adverse effects of a magnitude to have long-term population-level effects appears to be a low-likelihood event. The MMS would require an

OSRP to further reduce the opportunity for spilled oil to reach environmental resource areas important to whales and remove oil from the marine environment.

Chronic small spills are not modeled by the oil-spill-trajectory analysis; however, negligible, temporary, nonlethal effects are anticipated from small spills. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of endangered bowhead, humpback, or fin whales is extremely low.

Considering the low probability of a large spill occurring, coupled with a variety of other factors that would need to be satisfied to result in population-level effects, the MMS anticipates that it is highly improbable that listed whales would be jeopardized as result of oil spills associated with the Proposed Action, and minor, temporary, nonlethal effects and mortality of some individuals are anticipated.

4.4.2.6.1.3.9. Anticipated Effects from Subsistence Hunting. Activities from the Proposed Action are not anticipated to contribute any effects to subsistence activities and harvest of bowhead whales. Anticipated effects of the closely regulated subsistence harvest of bowhead whales are discussed in Section 4.4.1.6.1.3.10. The harvest of bowhead whales for subsistence purposes would remain the major known human-caused mortality and is expected to continue at the current levels until 2012, at which time subsistence-harvest quotas may be revisited by the International Whaling Commission (IWC). Humpback and fin whales are not subject to harvest and not expected to be so in the future.

If additional recoverable oil and gas resources are discovered and produced from leases in the Beaufort Sea, subsistence hunting of endangered bowhead whales would continue. Depending on where discovery and production activities occur, MMS-required mitigation measures would ensure whale movement into harvest areas, subsistence-hunting activities, and opportunity to harvest bowhead whales are not impaired or enhanced by OCS actions. The OCS activities are not anticipated to alter the subsistence harvest or the vulnerability of bowhead whales to harvest.

4.4.2.6.1.3.10. Anticipated Effects from Changes in the Physical Environment. Trends in arctic warming are anticipated to continue, and potential or predicted effects are discussed in Section 4.4.1.6.1.3.11. Direct and indirect effects of arctic warming remain speculative as to timing, magnitude, and intensity. These trends are outside the scope and influence of the Proposed Action. Continuing monitoring, evaluation, and appropriate ESA Section 7 consultation procedures will allow MMS and others to adjust activities, as appropriate, to protect endangered whales.

The contribution of petroleum produced and the energy consumed to explore and produce petroleum from the Proposed Action to arctic warming would be incremental, not detectable, and inconsequential to direct effects to endangered whales. If petroleum was not discovered or produced, U.S. and world demand for and consumption of petroleum would continue to be met by other worldwide sources, and the contribution to the global greenhouse gases and resulting climate change trends and effects would not change. It is anticipated that the Proposed Action would have negligible effects on changes to the physical environment resulting from arctic warming, greenhouse gas emissions and subsequent effects to endangered whales.

4.4.2.6.1.4. Direct and Indirect Effects Under Alternative 2.

Summary. Temporary and nonlethal effects to ESA listed bowhead and humpback whales are anticipated from displacement and disturbance from routine exploration, seismic, and drilling activities. Potential endangered whale injury or mortality of very few individuals is anticipated to occur from whale-vessel interaction and collision associated with routine exploration activities. Negligible effects to

productivity, recruitment, fitness, and survival of individuals or the populations of bowhead or humpback whales are anticipated. No effects to fin whales are anticipated, as this species is not expected to occur in the Beaufort Sea.

The proposed lease sales could result in development and production activities; however, such activities remain speculative. Activities associated with development and production were analyzed to determine effects on endangered whales, if such a discovery occurs and is proposed to be developed in the future. Temporary, nonlethal effects to bowhead and humpback whales are anticipated to occur as result of support-vessel traffic and noise; support construction, operation, and maintenance activities associated with development and production facilities; and abandonment. Collective effects of frequent disturbance, displacement from, ineffective use of important habitats, and increased opportunity for vessel-whale interaction injury and mortality are anticipated to result in minor, temporary, nonlethal effects, and some individuals would experience lower fitness, reproductive capability, survivorship, injury, or mortality not detectable at a population level. The extent, intensity, and magnitude of development and production activities and the exposure endangered whales could encounter remains speculative at this time. The unlikely occurrence of one or more large oil spills in the spring lead system could expose large numbers of bowhead whales and newborn calves to fresh oil and associated toxic aromatic hydrocarbon fumes and could represent moderate and major population level effects depending on the numbers and age of whales contacted and the duration of contact. Moderate effects are anticipated, if a large fresh oil spill results in prolonged contact of large numbers of feeding whales concentrated in high-density prey concentration areas during open-water periods.

4.4.2.6.1.5. Cumulative Effects Under Alternative 2.

The effects of OCS oil and gas operations on endangered whales have been assessed in a number of documents, including a Biological Evaluation (BE) of the *Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on endangered Bowhead Whales (Balaena mysticetus), Fin whales (Balaeoptera physalus) and Humpback Whales (Megaptera novaeangliae)* (USDOI, MMS, 2006c, 2008b); the Five Year Programmatic EIS (USDOI, MMS, 2007c), an ESA Biological Opinion (BO) for *Oil and Gas Leasing and Exploration Activities in the U. S. Beaufort and Chukchi Seas Alaska* (USDOC, NOAA, 2006a, NMFS, 2008c); an *Authorization of Small Takes under the Marine Mammal Protection Act* (USDOC, NOAA, 2006b); the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a); and environmental assessment updates for Lease Sales 195 and 202 (USDOI, MMS, 2004, 2006b).

If the proposed lease sale is held, there are past and existing environmental changes and conditions that may be sources of adverse effects to endangered bowhead and humpback whales, which are discussed in Section 4.4.1.6.1.4.1. These are expected to persist, and effects of the Proposed Action would be additive to them. Many of these activities and effects are beyond the authority of the OCS region to control, and some endangered whales and populations could be adversely effected over the next 40 years. Past and existing OCS activities and previous assessments not associated with Lease Sales 209 or 217 include mitigation measures to avoid or minimize effects on bowhead whales and other marine mammals. Activities beyond MMS authority may or may not be subject to mitigation measures or, in the case of commercial and private vessel traffic, aircraft traffic and climate change be subject to limited or no direct regulatory or mitigation measures regarding endangered whales.

The cumulative interaction of ongoing or existing activities and climate change processes may or may not adversely affect endangered whales, depending on the complex temporal, spatial, magnitude, rate of change, and many more variables that are unpredictable at this time. Climate change may create positive and/or negative effects to endangered whales. How and whether such potential changes would occur

singly or in combination would be highly speculative at this time, and continued intensive monitoring effort would be necessary to document changes, effects and to develop responsive management as appropriate. Increased human-caused activities could deflect and possibly alter nearshore spring and fall bowhead whale migration corridors that, in turn, may or may not adversely affect whales, their habitat, and human use of the whale resource. Such traffic could prevent effective duration of use or prevent bowhead and other endangered whale access to high-quality prey concentrations. Frequent encounters and exposure to noise disturbance could reach levels of chronic and cumulative stress to some animals so as to impact health, social bonds, and productivity of individuals and, potentially, populations.

Small or large oil spills could occur as a result of Alternative 2. Spills associated with existing leases, prelease activities, and postlease activity from Sales 209 and 217 could occur as well as spills from those past, present, and foreseeable activities (e.g., shipping, military operations, cruise ships, refueling, vessel collision and grounding, State and Canadian oil and gas activity, aircraft crashes, etc.) not authorized by the Alaska OCS region. OCS spill occurrence and response has been analyzed in previous documents (USDOI, MMS, 2003a; USDOC, NOAA, 2006a) for past and existing OCS activities in the Beaufort and Chukchi seas. Most whales exposed to spilled oil are expected to experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, ingestion of oil-contaminated prey items, baleen fouling, reduced food resources, or temporary displacement from feeding areas. A few individuals may be killed, or temporarily or permanently experience sensory or physical impairment or tissue contamination as result of exposure to freshly spilled oil; however, the chance of a spill occurring and also contacting whale habitat during the periods when whales are present is considered low. Whales tend to avoid vessel traffic, noise, and human activity, and the percentage of the Western Arctic stock of bowheads affected is expected to be very low. The probability of an oil/fuel spill increases with more and broader regional distribution of oil- and gas-related activity, nonshipping vessel activity, refueling events, increased vessel transport of fuel and goods, and other activities or events that can result in spilled crude or refined petroleum. Potential climate change-induced increases in numbers, changes, and/or expansion in seasonal distribution and range by North West Pacific humpback and Western Arctic bowhead whales also could increase potential exposure of whales to oil in the event of spills, depending on the circumstances of a spill event.

Mitigation measures associated with foreseeable OCS exploration, development, and production, and with existing offshore lease areas, are expected to avoid or minimize adverse effects to whale migration-corridor use at key periods, minimize interference with availability of bowhead whales for subsistence hunts, and endangered whale use of important seasonal habitats and feeding areas. Monitoring of endangered whales would continue to document and provide data regarding climate change-induced alterations of whale populations, ecology, and human use from which to formulate and implement informed and adaptive decisions, as appropriate, to ensure the protection and recovery of endangered whales in the Beaufort Sea Planning Area relative to OCS activities, but not other activities beyond OCS authority that also would occur simultaneously with OCS actions. These other activities may or may not be subject to protective mitigation or process by which adaptive management protocols can actively avoid or minimize short- or long-term adverse effects on endangered whales. The selection of Alternative 2, the Proposed Action would not add substantially to the effects of Alternative 1, the no-action alternative (Section 4.4.1.6.1.4.1), and effects would remain minor.

4.4.2.6.2. Threatened and Endangered Birds.

Summary. In the following analysis, we determined that there likely would be few direct or indirect effects if the lease sales were conducted—there would be a negligible level of effect from vessel presence and noise, aircraft presence and noise, seismic airgun noise, petroleum spills, increased bird predator populations, subsistence hunting, habitat loss, and a continued minor level of effect from collisions with

structures. While the greatest potential for a major level of effect is associated with continuing physical changes in the arctic environment, the lease sales would not result in a direct effect on this impact category. The direct and indirect effects of this alternative were combined with the cumulative effects from Alternative 1, and the resultant levels of effect are the same as for Alternative 1. Mitigation measures imposed by MMS on future exploration and development activities on existing or new leases and surrounding waters avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. The MMS-authorized actions could result in a small incremental increase in or longer duration of some activities, the total effect would be proportionately lower when compared to similar, but unrestricted activities in the area.

This analysis identifies the anticipated level of effect for this alternative on threatened and endangered birds. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.2.6.2.3.1) and cumulative effects (Section 4.4.2.6.2.3.2). As threatened and endangered birds represent a resource group, we address differential effects to each species in Section 4.4.2.6.2.4.

4.4.2.6.2.1. Potential Effects to Threatened and Endangered Birds. The potential effects for threatened and endangered birds in the Beaufort and Chukchi seas were described in Section 4.4.1.6.2.1 and are not repeated here.

4.4.2.6.2.2. Mitigation Measures. The potential effects would be moderated by the mitigation measures listed in Section 4.4.1.6.2.2 for prelease seismic surveys, State- and locally-authorized activities, and relevant portions of Stipulation 2 below (see Appendix F).

Stipulation No. 2 – Measures required to minimize effects on species listed under the Endangered Species Act.

Operations conducted in support of exploration and development activities on this OCS lease are required to adhere to the conditions of the most recent Biological Opinions issued by the Fish and Wildlife Service and the National Marine Fisheries Service.

Summary of the Effectiveness. The Biological Opinion issued by the FWS specifies reasonable and prudent measures necessary and appropriate to minimize potential adverse impacts to protected species. To be exempt from the prohibitions of Section 9 of the Endangered Species Act, the MMS must comply with the terms and conditions identified in the Biological Opinion. This stipulation could reduce the potential for spectacled and Steller's eiders to strike structures, which would lessen the potential effects of OCS exploration and development on these species.

Information on the Spectacled Eider and Steller's Eider. Lessees are advised that the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*) are listed as threatened by the Fish and Wildlife Service (FWS) and are protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Spectacled eiders and Steller's eiders are present in the Chukchi Sea during spring migration in May and June. Males return to the open sea in late June, while nesting females remain on the arctic coastal tundra until late August or early September, when they move to coastal areas of the Beaufort and Chukchi seas for brood-rearing. Molting eiders occur in certain offshore areas until freeze-up (typically in November). Onshore activities related to OCS exploration, development, and production during the summer months (May-September) may affect nesting spectacled eiders and Steller's eiders.

Lessees are advised that exploration and development and production plans submitted to MMS will be reviewed by the FWS to ensure that spectacled eider, Steller's eider, and their habitats are protected. For the proposed lease sales, MMS is specifically requesting an incremental Section 7 consultation with the FWS. The MMS will consult with FWS on potential effects of leasing and seismic/exploration activities.

As few details are known regarding the specific location/design of a future development, therefore that stage of activity will require further consultation with the FWS. To allow this stepwise approach, FWS must find that the leasing and seismic/exploration stage of the lease sales would not result in a jeopardy determination to either the Steller's eider or spectacled eider nor would adverse modification of spectacled eider critical habitat occur.

The FWS must also evaluate our evaluation of potential development and production that could occur as a result of leasing and exploration locating a commercially viable discovery and conclude that there is a reasonable likelihood that the entire action will not violate Section 7(a)(2) of the Endangered Species Act. Section 7(a)(2) of the Act requires that Federal agencies ensure their actions are not likely to jeopardize the continued existence of any endangered or threatened species or adversely modify designated critical habitat. Lessees are advised that future development projects arising from lease sales in the Chukchi (212 and 221) and Beaufort (209 and 217) seas will be subject to future Section 7 consultation with the FWS and a future project would not be authorized by MMS if it is likely to result in jeopardy or adverse modification of designated critical habitat as determined by FWS.

Stipulation 2 states that leases are required to adhere to the conditions of the most recent Biological Opinion issued by the FWS pertaining to post-lease activities. At the time the DEIS was prepared, the following conditions apply to the Beaufort Sea.

Beaufort Sea: Measures to Minimize Effects to Spectacled and Steller's Eiders during Exploration Activities in the Beaufort Sea.

The following measures minimize the likelihood that Steller's and spectacled eiders would strike drilling structures or vessels. They also provide additional protection to eiders within other important areas, including the Ledyard Bay Critical Habitat Area, during times when eiders are present. The mitigation measures would protect ESA-listed and other marine and coastal birds during seismic activities and exploration drilling operations in the Beaufort Sea. These measures are consistent with recent Section 7 consultations for Lease Sales 186, 195, and 202 and programmatic seismic activities in the Beaufort Sea. Case-by-case exceptions require reconsultation under the ESA with the FWS.

A) General Conditions. The following conditions apply to all lease exploration and support activities.

- (1) Vessels will minimize the use of high-intensity work lights, especially within the 20-m-bathymetric contour. Exterior lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they will be turned off. Interior lights and lights used during navigation could remain on for safety.
- (2) An Exploration Plan, ancillary activities, and other proposed lease activities must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or drilling structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, identification of the vessel, aircraft or drilling structure involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the U.S. Fish and

Wildlife Service (FWS) does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

B) Seismic Activities. The following conditions apply to any seismic survey activities and supporting vessels and aircraft supporting those activities.

- (1) No vessels associated with Beaufort Sea seismic survey activity en route to the Beaufort Sea will be permitted within the Ledyard Bay Critical Habitat Area following July 1 of each year, unless human health or safety dictates otherwise.
- (2) Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters of the Beaufort Sea as much as possible. Support aircraft associated with Beaufort Sea seismic survey activities are not expected to operate over the Ledyard Bay Critical Habitat Area. If so, however, aircraft must avoid overflights across the Ledyard Bay Critical Habitat Area below an altitude of 1,500 feet (450 meters) after July 1 of each year, unless human health or safety dictates otherwise.
- (3) Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic substance spill. If seismic-related vessels transit through the spring lead system before June 10 they may encounter concentrations of listed eiders. These vessels are required to have wildlife hazing equipment (including Breco buoys or similar equipment) pre-staged, and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site Oil Spill Response Vessel, in order to ensure rapid deployment in the event of a spill.
- (4) The spring lead system is defined as the Ledyard Bay Critical Habitat Area as well as the Federal OCS areas landward from an imaginary line extending from the outer corner of the Critical Habitat Area (70°20'00" N. x 164°00'00" W.) extending northeast to the southeastern-most corner of the Lease Sale 193 Sale Area (71°39'35" N. x 156°00'00" W.) and the area landward of an imaginary line drawn between Point Hope and the other outer corner of the Ledyard Bay Critical Habitat Area (69°12'00" N. x 166°13'00" W.).

C) Drilling Activities. The following conditions apply to operations conducted in support of exploratory and delineation drilling.

- (1) Surface vessels (e.g., boats, barges) associated with exploration and delineation drilling operations should avoid operating within or traversing the Chukchi Sea spring lead system between April 15 and June 10 to the maximum extent practicable. If surface vessels must traverse this area during this period, the surface vessel operator will have ready access to wildlife hazing equipment (including at least 3 *Breco* buoys or similar devices) and personnel trained in its use; hazing equipment may be located on-board the vessel or on a nearby Oil Spill Response Vessel, or in Point Lay or Wainwright. Lessees are required to provide information regarding their operations within the area upon request of MMS. The MMS may request information regarding number of vessels and their dates of operation within the area.
- (2) Except for emergencies or human/navigation safety, surface vessels associated with Beaufort Sea exploration and delineation drilling operations will avoid travel within the Ledyard Bay Critical Habitat Area between July 1 and November 15. Vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.

D) Lighting Protocols. The following requirements apply to all new and existing Outer Continental Shelf oil and gas leases issued west of 146° W. longitude for activities conducted between April 15 and November 15. The MMS encourages operators to consider such measures in areas to the east of 146° W. longitude because occasional sightings of listed eiders have been made there and because such measures could reduce the potential for collisions of other, non-ESA listed migratory birds that are protected under the Migratory Bird Treaty Act.

Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration or delineation drilling structures to minimize the likelihood that birds would strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures while operating on a lease or if staged within nearshore federal waters pending lease deployment.

Measures to be considered include but need not be limited to the following:

- (1) Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
- (2) Types of lights;
- (3) Adjustment of the number and intensity of lights as needed during specific activities;
- (4) Dark paint colors for selected surfaces;
- (5) Low-reflecting finishes or coverings for selected surfaces; and
- (6) Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches that could be applied to their specific facility and operation to reduce outward light radiation. Lessees must provide MMS with a written statement of measures that will be or have been taken to meet the lighting objective and submit this information with an Exploration Plan when it is submitted for regulatory review and approval pursuant to 30 CFR 250.223.

Nothing in this ITL is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

4.4.2.6.2.3. Anticipated Effects Under Alternative 2. In this section, we determine the anticipated level of effect on threatened and endangered birds if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. These anticipated effects consider mitigation measures (identified above) and other important factors (timing, residence time and productivity, spatial extent, etc.) described in Section 4.4.1.6.2.3. We also defined the terms used to describe the anticipated level of effect in Section 4.4.1.6.2.3. The anticipated effects from implementing this alternative are separated into the direct and indirect effects (Section 4.4.2.6.2.3.1) and the cumulative effects (Section 4.4.2.6.2.3.2) of implementing this alternative. As threatened and endangered birds represent a resource group, we address differential effects to specific species in Section 4.4.2.6.2.4.

4.4.2.6.2.3.1. Direct and Indirect Effects Under Alternative 2.

Summary. The loss of a small number of spectacled and Steller's eiders as a result of collisions with offshore structures is anticipated to result in a minor level of effect on Steller's and spectacled eiders from routine exploration activities. Disturbance in or displacement from important habitats from exploration activities are anticipated to have a negligible level of effect on the fitness or survival of individuals or production of young under this alternative.

Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on threatened and endangered bird populations, if such a discovery is made and proposed for development in the more distant future. Such production-related activities include habitat losses due to construction of development/production facilities, collisions with certain structures, and the potential for oil spills. Potential habitat losses would displace eiders from

nesting areas, but nesting habitat is not believed to be limiting these species on the Arctic Coastal Plain (ACP), and long-term adverse effects are not anticipated. Estimated mortality of spectacled eiders during production, including habitat loss, collisions, and hypothetical spills, could represent a major level of effect.

4.4.2.6.2.3.1.1. Anticipated Level of Effect from Vessel Presence and Noise. Oil and gas exploration and development in the Beaufort Sea OCS are anticipated to result in disturbance potential experienced by Steller's and spectacled eiders. Mitigation measures imposed by MMS on future exploration and development activities avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. Vessel activities associated with the Proposed Action are anticipated to have a negligible level of effect on ESA-protected birds.

4.4.2.6.2.3.1.2. Anticipated Level of Effect from Aircraft Presence and Noise. Low-level aircraft traffic could adversely affect listed birds by: (1) displacing adults and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. The behavioral response of eiders to low-level aircraft flights is unknown; some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate frequent aircraft noise. Individual tolerances are expected to vary, however, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport.

Disturbance to nesting spectacled and Steller's eiders probably is limited due to their extremely low densities across the North Slope. Across the ACP of the North Slope, breeding season density averages approximately one pair per 8 km² for spectacled eiders (Larned, Stehn, and Platte, 2003). Steller's eiders are so rare in some years that they are not detected at all by aerial-survey methods. In the core of the Steller's eider breeding area near Barrow, the highest nesting density recorded during 4 years of aerial surveys was estimated as approximately one pair per 12.5 km² (Ritchie and King, 2002). Densities elsewhere on the ACP are much lower.

The number of nesting Steller's or spectacled eiders that would be exposed to low-level flights associated with OCS oil and gas exploration is low, because the potential direct flight from an air base to offshore work sites within the OCS would be primarily over coastal waters. Mitigation measures imposed on future exploration activities avoid or minimize adverse effects to ESA-listed birds rearing or staging in the Beaufort Sea. Aircraft activities associated with the Proposed Action are anticipated to have a negligible level of effect on ESA-protected birds.

4.4.2.6.2.3.1.3. Anticipated Level of Effect from Collisions. The MMS cannot assume that recommendations for the design and implementation of lighting of structures would result in no strikes by threatened eiders. The MMS and FWS both acknowledge that estimating incidental take of listed eiders is extremely difficult due to a lack of available information. An estimated incidental take of listed species was calculated in the BO for the Beaufort Sea Lease Sale 186 (USDOJ, FWS, 2002). Collisions with preproduction structures on existing leases in the Beaufort Sea OCS were calculated to result in an incidental take of five spectacled eiders and one Steller's eider (USDOJ, MMS, 2003a). Mitigation measures imposed on future exploration and development activities are believed to minimize collision mortality to ESA-listed birds in the Beaufort Sea.

The MMS considers the incidental take to be an unavoidable, but minor level of effect to listed eiders. A negligible level of effect on Kittlitz's murrelets is anticipated. No population-level of effect to ESA-listed birds is anticipated.

Although production from existing Beaufort Sea leases is speculative (i.e., not reasonably foreseeable), we calculated that as many as 21 spectacled eiders (calculated as = 0.40 (spectacled eider strike rate) x 26 years (life of production) x 2 (maximum number of platforms)) and one Steller's eider (calculated as = 0.02 (Steller's eider strike rate) x 26 years (life of production) x 2 (maximum number of platforms)) would occur from collisions with structures associated with production drilling on existing leases in the Beaufort Sea OCS. Further Section 7 consultation with FWS under the ESA would be required for any proposed development of Beaufort Sea OCS leases. The MMS would not authorize any development proposal that was determined to be likely to jeopardize the continued existence of an ESA-listed species.

4.4.2.6.2.3.1.4. Anticipated Level of Effect from Petroleum Spills. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of ESA-protected birds because of their ability to spread and persist. Exposure of spectacled and Steller's eiders and Kittlitz's murrelets is expected to result in the general effects reviewed in Section 4.4.1.6.2.1.4. This analysis assumes that all birds contacted by oil would not survive, and that secondary effects may cause impaired physiological function and production of fewer young. The mitigation measures described in Section 4.4.2.6.2.2) would be implemented for the proposed lease sales. A large spill from a well blowout is described as a very unlikely event, and no large oil spills are assumed to occur during exploration activities (Appendix A, Section 1.1.4).

It is important to remember that a large spill event associated with OCS oil and gas activities likely would occur only during the production phase, when volumes of oil or gas product is being moved to production facilities in the existing facilities at Kuparuk or Prudhoe Bay. Section 4.4.1.6.3.2.4 (Anticipated Level of Effect to Threatened and Endangered Birds - Petroleum Spills) describes the basis for concluding that oil or gas production resulting from the proposed lease sales is considered speculative, and production effects are not considered reasonably foreseeable. Such a commercial discovery warranting production has not been identified or proposed for development and is considered speculative at this time. In other words, while MMS and FWS acknowledge that a large spill could have a major level of effect on ESA-protected species, a large spill from production activities is not considered a reasonably foreseeable future event.

The MMS models large spills to estimate the percent chance that a spill of certain size could contact important environmental resource areas, and then analyzes the potential effects from oil spills to determine which resource areas might have the highest chance of contact. In the following sections, we evaluate the vulnerability of spectacled and Steller's eiders and Kittlitz's murrelets to oil spills (oil-spill-risk analysis), then we describe the effect of disturbance from oil-cleanup activities, the effects of prey reduction or contamination, and the anticipated effects of that mortality on ESA-listed bird populations.

Vulnerability of ESA-Listed Birds to Oil Spills. Spectacled and Steller's eiders essentially are absent from the Beaufort Sea from late October to May. Eiders returning to the breeding grounds in the spring often encounter sea ice in offshore areas and must stage in the Chukchi Sea before heading overland to nest sites. An excellent map depicting spectacled eider nesting areas is in Larned, Stehn, and Platte (2006, Figure 17). After breeding, the males often return overland to open waters in the Chukchi Sea, spending little, if any, time in the Beaufort Sea. Late-departing males and failed nesting females may head north to open waters of the Beaufort Sea as spring progresses and coastal ice has receded. A few satellite-tagged males were relocated in Simpson Lagoon and Harrison Bay (USDOI, MMS, 2003a: Figure 9b). In late August once all the chicks in a nest hatch, the hen moves the brood to coastal areas for rearing. An increasing number of female and juvenile eiders move to these nearshore areas as the broodrearing season progresses. Once the chicks are flight capable, the broods move west out of the Beaufort Sea to molting areas in the Chukchi Sea, particularly Ledyard Bay. Bird mortality associated with an oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use and stage of annual cycle at the time of contact (for example, molting versus nonmolting).

4.4.2.6.2.3.1.4.1. Oil-Spill Analysis. The potential for spills to contact ESA-protected species in the Beaufort Sea was described in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a). Due to small adjustments in the environmental resource area polygons (size/shape), changes in lease areas, and other model refinements, we have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are much the same as those for the previous lease sales in the Beaufort Sea.

The spill rate of large platform and pipeline spills during production is 0.58 spills (95% confidence interval = 0.26-0.78) per billion barrels with a 26% chance of one or more large spills occurring over the 20 year of the project (Table A.1-26). For the development and production phases, the fate and behavior of a 1,500-bbl crude or condensate spill from a platform and a 4,600-bbl crude or condensate spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl crude spill would cover a smaller area (181 km²) (Table A.1-6) than a 4,600-bbl crude spill (320 km²) (Table A.1-7) after 30 days. The OSRA uses the center of the spill mass as the contact point, so the chances of either spill contacting specific environmental resource areas would be the same. Because of this similarity, the 4,600-bbl spill is analyzed from this point on.

A 4,600-bbl spill could contact environmental resource areas where Steller's and spectacled eiders and Kittlitz's murrelets may be present (Appendix A). Approximately 40% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km².

Conditional Probabilities. This section discusses the chance that a large oil spill from the Beaufort Sea lease-sale area could contact specific environmental resource areas (ERAs) that are important to Steller's and spectacled eiders and Kittlitz's murrelets, assuming a large spill occurs.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting Steller's and spectacled eider and Kittlitz's murrelet habitats assuming a spill occurs. This analysis uses ERAs 1, 2, 8-10, 19, 65, 68, 69, 71-73, 77, and 81. The tables and maps are found in Appendix A. Conditional probabilities assume a large spill occurs (see definition and applications, Appendix A).

Summer Spill. The following discussion summarizes the results for launch areas (LAs) 1-25 and pipelines (PLs) 1-17 during summer, unless otherwise specified. The OSRA model estimates the chance of a large oil spill contacting any coastal or offshore ERA important to ESA-protected eiders (Tables A.1-13 and 14) from LAs within 30 days is <0.5-52% (Table A.2-65) and <0.5-44% from PLs (Table A.2-66), depending on the distance between the resource areas and the source of the spill (Maps A.1-4 and A.1-2a through e). If groups of land segments are considered, the chance of a large spill contacting the U.S. Beaufort Sea coastline within 30 days is <0.5-63% (Tables A.2-89 and 90, Map A.1-3d).

The OSRA model estimates a <0.5-54% chance that a large oil spill will contact ERAs important to ESA-listed birds within 180 days from LAs and a <0.5-45% from PLs (Tables A.2-69 and 70). The highest percent chance of contact is 54% to ERA2, Point Barrow and the Plover Islands, from a spill originating at LA2 (Table A.2-69). The chance of contact to this resource area is highest, because the LA and the ERA are in close proximity to or overlap each other (Maps A.1-2a and A.1-4). Other adjacent LAs 1-6 have 13-35% chance of contacting ERA2 within 180 days (Table A.2-69). The highest percent chance of contact is to ERA68, Harrison Bay, which has a 45% chance of contact from PL9 within 180 days (Table A.2-70). As with the LAs, the chance of contact to this ERA is highest because the PL and the ERA are in close proximity to or overlap each other (Maps A.1-2a and A.1-4).

Spectacled eiders must stage offshore in the spring if their breeding habitats are unavailable. The spring lead system, ERA19, is used by spectacled eiders during spring (April-June); the highest percent chance of contact to ERA19 is <0.5% from any launch area within 180 days (Table A.2-69). Similarly, a spill originating from any pipeline segment would have <0.5% chance of contacting spectacled eiders using ERA19 within 180 days (Table A.2-70).

Most postbreeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Area (ERA10). A large spill originating from any launch area or pipeline segment has a <0.5% chance of contacting spectacled eiders in the Critical Habitat Area during the May-October open-water period within 180 days (Tables A.2-69 and 70).

As Steller's eiders occur in low numbers, specific coastal areas and nearshore waters important to Steller's eiders in the Beaufort Sea have not been identified. Coastal waters important to spectacled eiders include Harrison Bay/Colville River Delta (ERA69), Simpson Lagoon (ERA71), and the Plover Islands (ERA2). The highest chance of contacting ERAs 69, 71, and 72 is 36%, 11%, and 52% from LAs 8, 10, and 2, respectively, within 30 days. This suggests a high percent chance of contact, and it is possible that mortality of low hundreds of spectacled eiders could occur. As noted, this analysis is only for purposes of modeling and to determine which areas would have the highest chance of contact; the foregoing percent chances of contact assume that a large spill occurs.

Winter Spill. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during winter, unless otherwise specified. The OSRA model estimates up to a 30% chance that a large oil spill from an LA and up to a 32% chance from a PL will contact ERAs important to ESA-listed eiders within 180 days (Table A.2-117 and A.2-118). The highest chance of contact from a PL occurs to ERA68, Harrison Bay, which has a 32% chance of contact from PL9 within 180 days. The highest chance of contact (30%) from an LA occurs from LA2 contacting ERA2, Point Barrow and the Plover Islands (Table A.2-117). The OSRA model estimates the chance of a large spill from LAs 1-6 contacting ERA2 ranges from 10-20% within 180 days. The chance of contact tends to be highest where the LAs and PLs and the ERA are in close proximity to or overlap each other (Table A.2-117 and A.2-118).

Most postbreeding spectacled eiders move offshore and then migrate west to the Ledyard Bay Critical Habitat Area (ERA 10). A large spill originating from any LA or PL would have a <0.5% chance of contacting the Critical Habitat Area within 180 days, melting out in spring (Tables A.2-17 and 118). On an annual basis, a large spill originating from any LA or PL has a <0.5% chance of contacting any ERA important to ESA-listed birds, including the Ledyard Bay Critical Habitat Area (ERA10), within 180 days (Appendix A, Table A.2-21).

If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

Combined Probabilities. Combined probabilities differ from conditional probabilities in that they do not assume that a spill has occurred and consolidate nonuniform weighting of launch probabilities into one unit probability. The risk that a large spill would occur is multiplied by the areawide probability that spilled oil would reach a particular ERA to calculate a combined probability that both would occur simultaneously. Combined probabilities are defined in Appendix A (Section 4.3). The combined probabilities for a large spill occurring and reaching ERAs of most concern to threatened bird species are in Table 4.4.2.6.2-2. These probabilities are broken into different periods to indicate volatility, weathering, and movement of the spill over time.

If the chance of spill occurrence is incorporated, the combined probability of one or more large oil spills occurring and contacting any ERA north of the spectacled eider breeding range (ERAs 2, 8, 9, 71-73, 77, 78, and 96; Maps A.1-2a through e) within 30 days is $\leq 1\%$ over the 20-year production life of the Proposed Action (Table A.2-157). While more development may be expected to occur in the vicinity of Prudhoe Bay because of the proximity to primary support facilities, the combined probability of contacting ERAs important to ESA-listed birds offshore of this area does not exceed 1%. Flocks foraging inside the barrier islands (~50% of the coastline has adjacent islands) are protected to some extent from oil-spill contact.

Chronic, Low-volume Spills. Small or low-volume spills are defined as being <1,000 bbl. The average crude-oil spill size is 126 gal (3 bbl) for spills <500 bbl. An estimated 89 small crude oil spills would occur during the 20-year oil production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average refined oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined oil spills would occur during the 20-year oil production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur each of the 20 years of production.

It is unknown how many small-volume spills or what total volume would reach areas used by Steller's or spectacled eiders or Kittlitz's murrelets. If these low-volume spills were in close proximity to or within the Ledyard Bay Critical Habitat Area, a large number of molting spectacled eiders could be contacted and injured or killed. Kittlitz's murrelets or Steller's eiders close to the source of these spills could also be affected, but these birds are at lower densities and substantial adverse effects would not be expected to occur.

Spill-Response Activities. None of the conditional or combined probabilities factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Activities such as hazing and other human activities (e.g., vessel and aircraft traffic) could impact threatened eiders and Kittlitz's murrelets. Hazing may have limited success during spring when migrants occupy open water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to adversely affect listed eiders.

The presence of large numbers of cleanup workers, boats, and additional aircraft is likely to displace spectacled and Steller's eiders from affected offshore, nearshore, and/or coastal habitats during open-water periods for one to several seasons. Although little direct mortality from cleanup activity is likely, predators may take some eggs or young while females are displaced off their nests if located near a site of operation. Disturbance during the initial season, possibly lasting 6 months, is expected to be frequent in some areas. Cleanup in coastal areas late in the breeding season may disturb small flocks of flightless broods, and some may be displaced from favored habitats, expending energy stores accumulated for molt/migration. Survival and fitness of individuals may be affected to some extent, but this disturbance would not be likely to result in more than a minor effect. Again, this assumes that a spill occurs and that an area important to these birds is affected when they are there.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with FWS and State

officials on wildlife-management activities in the event of a spill. In an actual spill, the two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, FWS personnel would be largely responsible for providing critical information affecting response activities to protect listed birds in the event of a spill.

Oil-spill-response plans typically do not spell out specific wildlife-response actions. They typically identify the resources at risk and refer to the appropriate tactics. The response contractor also can contract with other response organizations to augment animal hazing and response activities. The response contractor would be expected to have an inventory of bird scare devices in addition to the *Breco* buoys (air cannons, guns, vessels, pyrotechnics, and visual devices) to deter birds from entering the spill area and would be assumed to cycle their use to ensure that the birds do not habituate to their effect.

For purposes of evaluating the potential impact of a large spill on threatened or candidate bird species, oil-spill-response in the Chukchi Sea is assumed to be ineffective due to the unpredictability of response time, proximity of the launch area(s) to bird habitats, certain environmental conditions (e.g., broken ice), and the large number of birds that could be impacted in a brief time period (<36 hours).

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce survival or reproductive success of the portion of populations occupying or nesting in the local area affected. This generally is not likely to affect a large proportion of Steller's or spectacled eider populations, because they exhibit a dispersed breeding distribution. However, it could be more serious if these populations are experiencing a population decline. Lowered food intake may slow the completion of growth in young birds, the replacement of female energy reserves used during nesting, and energy storage for migration of all individuals. However, the contamination of some local habitat areas is not likely to affect a large proportion of the population, because they are likely to have access to alternative foraging habitat similar in appearance and with similar prey organisms present that is widely distributed in the region (for details, see USDO, MMS, 2002: Section III.C.2.c).

Anticipated Mortality from an Oil Spill. A large oil spill occurring in the Beaufort Sea during summer or fall periods most likely would contact broods of spectacled or Steller's eiders in certain open-water marine habitats. Some of these areas in the Beaufort Sea have been identified as the Plover Islands off Barrow, Simpson Lagoon, and Harrison Bay, which generally are north, offshore of nesting areas. The percent chance of contact is lowered by species being concentrated in relatively few scattered flocks during the brief period present (Stehn and Platte, 2000:Table 1; Fischer, Tiplady, and Larned, 2002). Stehn and Platte (2000) concluded that the spectacled eider was one of the species least likely to have a high proportion of their populations exposed to oil because of their widespread distribution or tendency to occur farther from the spill source, the source being the Liberty development (then proposed for Foggy Island Bay).

Stehn and Platte (2000) modeled the potential mortality to waterbirds resulting from a hypothetical spill originating from the Liberty Development in Foggy Island Bay. The authors estimated an average population of 540 spectacled eiders occurred in this area in July. In this example an average number of two (range 0-52) spectacled eiders would be exposed to oil from a 5,912-bbl spill. This would represent 0.003% of the estimated population vulnerable at that time. Calculated mortality for a similar spill during August was 0.00 (Stehn and Platte 2000:Table 5).

While the Stehn and Platte (2000) example illustrates the low potential for spectacled eiders to be affected by a hypothetical spill, potential for more severe impacts would increase if launch areas originated farther west, where more eider broods were rearing or moving through enroute to a molting area in the Chukchi

Sea. The anticipated population effect likely would be low to moderate, even if mortality were to approximate 125 birds, because most of these birds would be first-year birds that have a higher natural mortality rate; this number represents a small proportion of the entire North Slope fall population ($125/33,848 = 0.37\%$). The spectacled eider population appears to have stabilized over the 2000-2006 time period (Stehn et al., 2006), and a growth rate of 1.016 could be expected to allow recovery of these lost birds in less than a generation. Furthermore, these relatively small losses may be difficult to separate from natural variation in population numbers. This has been found for other waterbird populations under similar circumstances (for details, see USDOJ, MMS, 2002: Section III.C.2.a(2)).

Summary of Spill Effects. To put the risk of a large spill having population-level effects in perspective, one has to consider several variables. First, to ever have an oil spill, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find ranged from 17% and 50%, indicating that production is unlikely (USDOJ, MMS, 2003a). Second, the location of the oil or gas find and subsequent development platform could influence the probability that a spill would occur as well as the probability that it would reach resource areas important to threatened or candidate bird species when the species are present, or, in the case of a winter spill, when those birds return. Finally, the number and sex/age of threatened or candidate birds affected would have differing degrees of population-level effects, from a few birds in an area to all birds in an area during particular time periods. Given the stated low chance of successful oil field development, the low likelihood that a large spill would occur, and the low percent chance that a large spill would reach a resource area important to murrelets and threatened eiders, an adverse effect of this magnitude appears to be a low-likelihood event.

Anticipated mortality associated with these modeled events would represent <1% of the October North Slope spectacled eider population. Consequently, the ITL is consistent with the previous lease-sale Section 7 consultation documents:

...the low probability of such an event, combined with the uncertainty of the location of the spill, and the seasonal nature of the resources inhabiting the area, make it highly unlikely that a large oil spill would contact a threatened eider. Spectacled and Steller's eiders are present on the North Slope for only 3-5 months out of the year. Even if an eider were present in the vicinity of an oil spill, it might not be contacted by the oil due to avoidance behavior, ice conditions or weather patterns. Furthermore, the MMS requires companies to have and implement oil-spill-response plans to help prevent oil from reaching critical areas and to remove oil from the environment.

If a commercially viable resource discovery is made and is considered for development, the MMS must complete Section 7 consultation with the FWS on a production plan. As with the Sale 193 final EIS (see Information to Lessees, Appendix F of this EIS), a future project would not be authorized by MMS if it was likely to result in jeopardy or adverse modification of designated critical habitat as determined by FWS. The MMS believes that this condition will help industry incorporate stringent spill-prevention measures into their plans that avoid the risk of population-level effects on ESA-protected species.

Chronic, low-level spills are not modeled by the trajectory analysis but could adversely affect small numbers of Steller's eiders and Kittlitz's murrelets. Although difficult to state with any certainty, a small-volume spill in close proximity to a large, dense flock of molting spectacled eiders could result in adverse impacts to perhaps several hundred eiders, and maybe more. Depending on the chronic nature of small spills, this situation could occur repeatedly. There appears to be little percent chance of this occurring from a large spill originating in the Beaufort Sea reaching the spring lead system or Ledyard Bay, where large flocks of eiders may be present. Similarly, smaller spills would have even less likelihood of reaching these areas. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of spectacled eiders on the North Slope is extremely low.

Considering the low probability of a large spill coupled with a variety of other factors that would need to be satisfied to result in mortality, MMS anticipates that it is highly improbable that listed eider mortality would result from oil spills associated with the Proposed Action, and a negligible level of effect is anticipated.

4.4.2.6.2.3.1.5. Anticipated Level of Effect from Increased Bird Predator Populations.

Increased predator populations would only arise from the construction of development and production facilities, which are not considered reasonably foreseeable at this time. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of structures or facilities that could be used by bird predators, such as ravens or foxes, these facilities would not be constructed or operated in a manner that would support bird predators.

A lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) recently has been implemented for the Liberty project and is anticipated to be implemented for future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the OCS. For this reason, a negligible level of effect from increased predator populations is anticipated.

4.4.2.6.2.3.1.6. Anticipated Level of Effect from Subsistence-Hunting Activity. Increased subsistence-hunting activity could arise only from the construction of development and production facilities, which are not considered reasonably foreseeable at this time. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of gravel roads that could be used by bird hunters, it is unknown whether increased access would result in an increased accidental or illegal harvest of spectacled or Steller's eiders. The long-term consequences of this speculative development would be evaluated in future NEPA documents and via formal consultation under the ESA but, at the present time, the Proposed Action would have a negligible level of effect on ESA-listed eiders.

4.4.2.6.2.3.1.7. Anticipated Level of Effect from Habitat Loss. Small amounts of temporary habitat loss of Steller's and spectacled eider migration habitats could occur from drilling exploration or delineation wells into the seafloor. An anticipated negligible level of effect is associated with potential temporary offshore exploration and delineation drilling. No critical habitat for ESA-protected birds has been designated in the Beaufort Sea.

Permanent habitat loss would only arise from the construction of development and production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure), which are not considered reasonably foreseeable at this time. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. While there likely would be an incremental increase in the total number of acres of eider habitat eliminated, nesting habitat has not been identified as a factor limiting eider populations. Indirect habitat losses could result from eiders and murrelets not using habitats near sites of industrial activity. Also, future filling of wetlands would be subject to U.S. Army Corps of Engineers permitting processes and a subsequent Section 7 consultation under the ESA.

Direct impacts to spectacled and Steller's eider nesting habitats arise from the facility footprint. The MMS can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but these were estimated (Table 4.4.2.6.2-1). Overall, these

developments are estimated to have a direct footprint of 3.41 km² (845 ac) in eider nesting habitats, resulting in an estimated take of four spectacled eiders and one Steller's eider. Overall, these zones of influence associated with development facilities have an estimated collective areal extent of 33 km² (8,327 ac) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders and 2 Steller's eiders (Table 4.4.2.6.2-1).

4.4.2.6.2.3.1.8. Anticipated Level of Effect from Seismic Airgun Noise. Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is done during winter, when ESA-protected birds are absent. Exploratory/delineation drilling, seismic work, and related support activities typically are conducted from vessels during the ice-free, open-water period. Mitigation measures that would be imposed on seismic survey operations to protect ESA-listed birds are listed in Section 4.4.1.6.2.2 and 4.4.2.6.2.2. The MMS will impose the mitigation measures on future exploration and development activities to avoid or minimize adverse effects to ESA-listed birds in the Beaufort Sea. A negligible level of effect from seismic activities is anticipated.

4.4.2.6.2.3.1.9. Anticipated Level of Effect from Changes in the Physical Environment. Changes in the physical environment are believed to result from climate changes superimposed on the vagaries of regional weather patterns. These long-term trends are outside the influence of the Proposed Action. The argument that potential sources of energy that could be generated from Arctic OCS oil or gas development contributes to further changes in the physical environment fails to recognize that America has large energy needs and energy not produced from the Alaska OCS would continue to be replaced by foreign imports. Overall, as America uses these fuels, it affects worldwide CO₂ levels/climate change to the same extent, regardless of their source. The Proposed Action is anticipated to have a negligible level of direct effect on greenhouse gas emissions.

4.4.2.6.2.3.2. Cumulative Effects under Alternative 2. The anticipated effects of the Proposed Action are combined with the anticipated effects of the no-action alternative to determine the cumulative effects for this alternative. Lease sales 212 and 221 likely would result in an increase in the number of leases in the Beaufort Sea OCS. Some of the existing leases will not be explored, and some were explored and will not be evaluated further by the time the lease lapses. While there may be an initial increase in the number of active leases following a sale, there will be a gradual decline in active leases over time.

Seismic surveys and exploration drilling could continue at existing levels due to a limited number of suitable or specialized vessels for conducting these activities. No more than two drill rigs could operate in the Beaufort Sea at any one time. Similarly, no more than six seismic-surveying activities could be completed during a season, an unrealistic number because there are not six seismic-surveying vessels available. It is more reasonable to assume that no more than three seismic surveys could be completed simultaneously in the Beaufort Sea. This level of activity would represent a continuation of the same level of effect as described for anticipated Federal oil and gas activities under the Reasonably Foreseeable and Speculative Future Events (Section 4.2), except that these activities likely would extend further into the future as new leases are granted. While MMS-authorized actions could result in a small incremental increase in some sources of potential impacts, required mitigation measures would limit these sources to proportionately fewer impacts compared to other unrestricted sources of impact in this area.

Impacts to ESA-listed birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic, all unrelated to OCS leasing activities, would continue to have a negative, moderate level of effect on threatened eiders. The greatest source of large noncrude oil spills would continue to arise from bulk-fuel deliveries to coastal villages.

The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase dramatically the potential for marine accidents and large fuel spills, which could result in major adverse effects on threatened and endangered birds. Continued climate change is anticipated to result in a major level of effect to threatened and endangered birds.

4.4.2.6.2.3.2.1. Species-Specific Effects.

Cumulative Effects to the Steller's Eider. Wetland fills from community and industry infrastructure development immediately would eliminate Steller's eider habitat compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites would continue to present a collision hazard, and small numbers of Steller's eiders are expected to be killed. Unrestricted vessel and low-level aircraft traffic would continue to be a chronic source of disturbance.

Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities would be achieved, because vessels and aircraft associated with these activities would be managed to avoid conflicts with eiders. Exploration and delineation activities present a risk that Steller's eiders would collide with a vessel or drilling structure. Despite mitigation measures to reduce the risk of this occurring, an incidental take of one Steller's eider was calculated to be killed by collision with drilling structures during exploration and delineation activities associated with existing leases in the Beaufort Sea (USDOJ, MMS, 2003a).

The overall effects of potential production (considered speculative) include periodic interruption of postbreeding Steller's eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders nesting outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.41 km² (845 ac) in eider nesting habitats, resulting in an estimated indirect take of two Steller's eiders (Table 4.4.21.6.2-1). We calculated a take of just over one (1.04) Steller's eider would occur from collisions with structures associated with production from existing leases in the Beaufort Sea.

The MMS considers the level of incidental take during exploration activities to be an unavoidable but a minor level of effect to Steller's eiders. No population-level of effect to Steller's eiders is anticipated.

Cumulative Effects to the Spectacled Eider. Wetland fills from community and industry infrastructure development immediately would eliminate spectacled eider habitat compared to the more gradual habitat changes expected to result from climate change. Collisions with existing or future developments at these and other sites would continue to present a collision hazard, and small numbers of Steller's eiders would be expected to be killed. Unrestricted vessel and low-level aircraft traffic would continue to be a chronic source of disturbance.

Reduction in some of the adverse effects associated with disturbance from oil and gas exploration activities would be achieved, because vessels and aircraft associated with these activities would be managed to avoid conflicts with eiders. For example, vessels would not disturb molting eiders, because they would not be permitted in the Ledyard Bay Critical Habitat Area after July 1 of each year, even if they were transiting to or from the Beaufort Sea.

Exploration and delineation activities present a risk that spectacled eiders would collide with a vessel or drilling structure or be struck by an aircraft. Despite mitigation measures to reduce the risk of this occurring, an incidental take of five spectacled eiders was calculated to be killed by collision with drilling

structures during exploration and delineation activities associated with existing leases in the Beaufort Sea (USDOJ, MMS, 2003a).

The overall effects of potential production (considered speculative) include periodic interruption of postbreeding and molting spectacled eiders migrating in nearshore coastal areas. Activity associated with the construction and operation or maintenance of onshore facilities (pipelines, roads, etc.) likely would result in a loss of eider nesting habitat and cause eiders nesting outside a zone of influence around these sites. Overall, these zones of influence associated with development facilities could have a collective areal extent of 3.41 km² (845 ac) in eider nesting habitats, resulting in an estimated indirect take of 36 spectacled eiders (Table 4.4.2.6.2-1). We calculated that as many as 21 spectacled eiders would collide with structures associated with production from existing leases in the Beaufort Sea OCS.

The MMS considers the level of incidental take during exploration activities to be an unavoidable but a minor level of effect to spectacled eiders. No population-level of effect to the spectacled eider is anticipated.

Cumulative Effects to the Kittlitz's Murrelet. The Kittlitz's murrelet has not been documented to occur in the Beaufort Sea, but large numbers recently have been reported just west of Barrow, and it appears reasonable that some occur east of Barrow. If some Kittlitz's murrelets occurred in the Beaufort Sea, they could be disturbed periodically when foraging. Most mitigation or conservation measures that benefit threatened eiders benefit murrelets as well.

Should production occur, chronic low-volume spills or a large platform or pipeline spill could result in the deaths of some Kittlitz's murrelets, but the number affected depends on the time and location of the spills.

Alternative 2 will have a negligible level of effect on any Kittlitz's murrelets in the Beaufort Sea.

Determination of Effects to ESA-listed and Candidate Species. It is determined through this analysis that the proposed Beaufort Sea lease sales 209 and 217 likely would have the following effects, as described by the ESA, on Steller's and spectacled eiders and Kittlitz's murrelets:

- Lease sales 209 or 217 could extend the duration of activities that may affect listed eiders. Comprehensive mitigation and other conservation measures will avoid or minimize potential adverse impacts to listed eider species. Despite these measures, a small number of eiders still could be killed by their collision with exploration structures and these mortalities are likely to adversely affect Steller's and spectacled eiders. This conclusion is based on MMS considering the potential levels of collision mortality to not be discountable or insignificant.
- Lease Sales 209 or 217 activities would have no direct effect on the Ledyard Bay Critical Habitat Area and the proposed activities would not result in an adverse modification of designated critical habitat.
- Lease sales 209 or 217 could present new sources of disturbance that could affect Kittlitz's murrelets if they occurred in the Beaufort Sea. Comprehensive mitigation measures will avoid or minimize potential impacts and the Proposed Action would have no effect on the Kittlitz's murrelet.

4.4.2.6.3. Polar Bear.

The following analysis describes the anticipated effects to the polar bear if the entire lease sale took place with no deferrals in the Beaufort Sea. In this section, we describe the anticipated effects on polar bears from the Proposed Action with the proposed mitigation measures in place. The proposed mitigation measures are described in Section 2.2, see also Section 4.4.2.6.3.3.

A complete description of the Proposed Action is located in Section 2.1 while the exploration and development scenario descriptions are located in Section 2.4.

4.4.2.6.3.1. Direct and Indirect Effects Under Alternative 2. The temporary displacement of some polar bears from preferred habitats is anticipated as a result of routine exploration activities. Chronic disturbance or displacement can have moderate effects over time. Mitigation measures currently are expected to moderate potential effects to polar bears. These measures may include conducting den surveys prior to the onset of industrial activities, avoiding dens by a prescribed distance and hazing bears away from ongoing activities. Mitigation will be determined on a case by case basis through consultation with FWS. Disturbance in or displacement from important habitats from exploration activities are anticipated to be temporary effects and to have only minor effects on the fitness or survival of individual bears (Tables 4.4.2.6.3-1 and 4.4.2.6.3-2).

Development and production activities could result from leases offered under the proposed lease sales, although production would not take place unless another commercially viable discovery is made in the OCS. Production is not considered reasonably foreseeable from these lease sales at this time, but effects from a production project are analyzed to determine the anticipated effects on the polar bear population, if such a discovery is made and proposed for development in the more distant future.

The primary impacts to polar bears from production-related activities include habitat losses due to construction of development/production facilities, pipelines and the associated infrastructure; and the potential for oil spills. Potential habitat losses on barrier islands and along the coast could displace polar bears from denning areas that appear to be increasing in importance. Fischbach, Amstrup, and Douglas (2007) have found that more dens are being located onshore than on sea ice (a shift from 40% to 60% of dens located onshore). Long-term displacement from preferred denning and feeding habitats could have adverse effects and result in a major impact to the polar bear population. Direct mortality of polar bears from production activities, including habitat loss and hypothetical spills, are not expected, but could represent a major level of effect.

4.4.2.6.3.2. Potential Effects to Polar Bears. The potential effects for polar bears of the various impact categories in the Beaufort and Chukchi seas were described in Section 4.4.1.6.3.1.

4.4.2.6.3.3. Mitigation Measures. The potential effects of MMS authorized activities would be moderated by the mitigation measures (NTLs and ITLs) listed in Appendix F and by the Lease Stipulations described fully in Section 2.2. Polar bears are currently listed as threatened under the ESA, therefore MMS will consult with FWS under the ESA and adopt conservation measures as necessary to ensure that any potential impacts from OCS activities do not risk jeopardizing the continued existence of the polar bear. Under the MMPA, MMS cannot authorize or permit activities that are likely to have more than a negligible impact upon polar bears. MMS would work with FWS to ensure that any take of polar bears from harassment or disturbance is at or below negligible levels as defined by the MMPA. Mitigation measures imposed by MMS and FWS on future exploration and development activities would avoid or minimize adverse effects to polar bears in the Beaufort and Chukchi seas. Mitigation measures have typically included an adequate OSRP (USDOJ, FWS, 1999), which requires staff training and oil-spill-response equipment on hand, conducting den surveys to locate active polar bear dens prior to the onset of authorized activities, avoiding dens by distances proscribed by FWS, having marine mammal observers on board vessels, and avoiding marine mammals by changing vessel course or speed to maintain a sufficient distance from the marine mammals in order to avoid disturbance events, or by avoiding some habitat areas altogether.

Stipulation 2 states that operations authorized or permitted by MMS will be required to adhere to conditions set forth in the most recent Biological Opinion issued by the FWS on polar bears. The BO is expected to outline specific conservation measures required to decrease the potential for impacts on the polar bear population. These may be in the form of RPMs (Reasonable and Prudent Measures) or Terms and Conditions (T & Cs). Many of these mitigation measures may already be in place through the MMPA/LOA process. Additional protective measures for habitats determined by the FWS to be critical habitat under the ESA may be enforced. FWS anticipates that the process of identifying and designating critical habitat for the polar bear may be completed in 2010.

Stipulation 1 proposed in this lease sale includes conducting an annual orientation program for all industry personnel which would include information on appropriate ways to avoid disturbing or interfering with marine mammals, including polar bears. This orientation program educates personnel on minimizing potential disturbances to polar bears. Stipulation 3 requires that no permanent facilities be located within 10 miles seaward of Cross Island. Cross Island is a very important site for polar bears aggregating on shore while waiting for freeze up and access to the offshore ice environment. This stipulation would protect a portion of that area and decrease the possibility that MMS authorized activities in the vicinity would impact polar bear movements. Notice to Lessees No. 08-A04 clarifies that MMS will not authorize or permit activities that may result in the take (as defined by the MMPA) of any marine mammal, unless the FWS has determined that any potential take that occurs incidentally to the proposed activity would result in a negligible impact to the species and the Lessee is in possession of an LOA or IHA. This insures that Lessees are advised to consult with the FWS prior to beginning any industry activities in areas that may be used by polar bears.

4.4.2.6.3.4. Anticipated Effects under Alternative 2.

4.4.2.6.3.4.1. Anticipated Effects from Vessel Traffic. An increase in active leases is likely to increase the ongoing level of exploration activities, and the temporary displacement/disturbance associated with exploration. Therefore, the level of vessel activities is expected to increase as a result of the Proposed Action, in addition to ongoing increases in shipping traffic and tourism that are associated with an increase in the open water season in the Beaufort Sea. More icebreaker traffic, particularly in the lead system, could result in minor impacts to polar bears. However, most offshore exploration activities take place during the open-water season, when effects on polar bears are minimized.

4.4.2.6.3.4.2. Anticipated Effects from Motorized Vehicle Presence and Noise. An increase in motorized traffic related to exploration activities is expected due to the Proposed Action. These exploration activities may include building ice roads, temporary ice islands as drilling platforms, helicopter flights to move crews and lightweight equipment, rollogons, snowmachines, vibrosis equipment and other motorized vehicles. The level of impact related to these activities will depend upon the timing and extent of activities occurring simultaneously.

If displacement is temporary and localized, impacts to polar bears are expected to be minor. Our scenario assumes the discovery and subsequent development of between one and four oil fields, potentially resulting in one new shorefall and land base. Given the scenario, we expect that although some displacement and disturbance of polar bears may occur, these impacts are expected to be minor and not to have adverse impacts.

4.4.2.3.6.3.4.3. Anticipated Effects from Subsistence and Other Harvests. Mitigation measures currently in place have been very successful in reducing human-bear interactions in relation to oil and gas industry activities. Bears occasionally may be hazed away from industry operations, but no mortality due to DLP take has occurred since the Beaufort Sea Incidental Regulations have been in place.

The Proposed Action is expected to have negligible additional impacts on subsistence or other harvest of polar bears.

4.4.2.3.6.3.4.4. Anticipated Effects of Petroleum Spills. The OSRA assessments of oil-spill impacts are based on a combination of estimates including the chance of one or more large spills occurring, spill size, spill duration, weather conditions, and the effectiveness of oil-spill response (i.e., containment and cleanup). Spills could occur on land or in the marine environment. Spills into the marine environment have the potential to travel with water currents or the ice and to spread rapidly, depending on season, wind, and weather conditions. Therefore, spills in the marine environment may have a greater potential to affect polar bears. The effects of exposure to oil on polar bears are reviewed in Section 4.4.1.6.3.1.4. This analysis assumes that polar bears contacted by oil would not survive, neither would polar bears that ingest substantial amounts of oil through eating oiled prey. Polar bears could come into contact with oil in the open lead system, in pack ice, on shorefast ice, along the coastline, or on barrier islands.

The same oil spill mitigation measures described for existing leases in the Beaufort Sea (USDOJ, MMS, 2006b:Section IV.C.3) would be implemented for the proposed lease sales. For the OSRA model, the chance that a large oil spill would contact a specific resource area assumes no cleanup or mitigation is in place. A large spill from a well blowout is described as a very unlikely event, and we assume that no large oil spills will occur during exploration activities (Appendix A, Section 1.1.4).

The OSRA model quantifies the percent chance that a large spill ($\geq 1,000$ bbl) could contact important environmental resource areas. We analyze the potential effects from oil spills to determine which areas would be at highest risk for each resource, in this case, polar bears. In the following section, we evaluate the vulnerability of polar bears to oil spills, describe the potential effects of disturbance from post spill clean-up activities, the potential effects of prey reduction or contamination, and the anticipated effects on polar bear populations.

Vulnerability of Polar Bears to Oil Spills. Polar bears inhabit the Beaufort Sea year round and are vulnerable to spills at any time of the year. Oil would remain highly toxic to polar bears even after the aromatic hydrocarbons have dissipated. After an oil spill occurs, the highly toxic aromatic hydrocarbons typically evaporate relatively quickly, sometimes within weeks if the oil is exposed to optimum environmental conditions. If the oil remains trapped in ice, frozen within sea ice for example, then the oil can retain aromatic hydrocarbons for months, until the oil eventually melts out and is exposed to wind and wave action. Although oil toxicity decreases over time with weathering, this does not necessarily decrease the risk from oiling to polar bears, because they are vulnerable to hypothermia once their coat becomes oiled and will continue to ingest oil through grooming in an effort to clean their coats.

In general, polar bears can be encountered throughout the ice-covered waters of the Beaufort Sea. They are less likely to be found in open water, but will swim considerable distances from ice to shore or vice versa. As sea ice breaks up in spring, polar bears follow the receding ice edge and may come ashore in late summer and fall, where they remain until the sea ice reforms in early winter. Large aggregations of polar bears may be vulnerable to a spill on Barter or Cross islands in late summer and fall, when they congregate in these areas to feed on bowhead whale carcasses. Indirect sources of mortality may occur when seals or other mammals die from oil exposure. Bears have an excellent sense of smell and will travel long distances to locate food sources. Given that polar bears have been observed chewing on oil cans and fuel bladders, as well as snow machines and, in one case, a car battery; it seems unlikely that polar bears would avoid their usual prey items due to oiling. Ingesting oiled prey likely would be a secondary source of mortality from a spill.

Oil-Spill Analysis. The potential for large spills to contact polar bear habitats in the Beaufort Sea was analyzed in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS 2003a). This analysis was updated in the EA for Sale 202 (USDOJ, MMS 2006b). We have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are similar to past analyses.

The following oil spill effects analysis presents conditional and combined probabilities expressed as percent chance. Conditional probabilities assume that a large spill has occurred, and model the chance of that spill contacting a particular environmental resource area (see Appendix A). Combined probabilities model the chance of one or more large spills occurring and contacting a particular resource area. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the environmental resource areas and Land Segments or Grouped Land Segments (GLSs). Locations of environmental resource areas are found in Maps A.1-2a through 2e and land segments in Maps A.1-3a through 3d. The OSRA model assumes that a spill starts at a specific launch area or pipeline segment. The launch areas and pipeline segments for the Beaufort Sea area are found in Appendix A, Map A.1-4. An environmental resource area can represent an area important to one or more species or species groups during a discrete amount of time. This section analyzes potential oil-spill impacts to polar bears. Oil-spill impacts to ice seals, such as ringed seals, could impact polar bears by limiting prey available to them, or by causing mortality from secondary contamination. These impacts are analyzed in the nonendangered marine mammals section (Section 4.4.2.8.3.1.7.).

Conditional Probabilities. This section discusses the chance that a large oil spill from the Beaufort Sea lease sale area would contact specific environmental resource areas that are important to polar bears. Conditional probabilities assume that a large spill has occurred.

The estimated chance that one or more large platform and pipeline spills will occur as a result of production from Lease Sale 209 or 217 is 26% over the 26-years of production. This estimated chance of a large spill remains constant, regardless of the selection of any combination of deferrals. This model assumes that three fields are developed, and that the life of each production fields is 20 years (Table A.1-26). For development and production phases, the fate and behavior of a 1,500-bbl oil spill from a platform and a 4,600-bbl oil spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A).

A 1,500-bbl platform spill occurring during the summer season (between July and September) would cover approximately 9 km² after 3 days and 181 km² of discontinuous area after 30 days, and could oil an estimated 29 km of coastline (Table A.1-6). A meltout spill of the same size from a platform would cover 7 km² after 3 days and 143 km² of discontinuous area after 30 days, and would oil an estimated 32 km of coastline (Table A.1-6). These examples highlight the critical importance of an immediate response from on-site oil-spill-response personnel and equipment, though winter cleanup would have limited effectiveness, particularly in broken-ice conditions.

A 1,500 or a 4,600-bbl spill could contact environmental resource areas where polar bears may be present (Table A.1-16). Approximately 40% of a 4,600-bbl pipeline spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer, potentially causing major impacts to polar bears. Approximately 69% of a 4,600-bbl pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km² (Table A.1-7).

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting identified polar bear habitats. Conditional probabilities are based on the assumption that a

large spill occurred (for further explanation, see Appendix A). For a map of the hypothetical platform locations (launch areas) and the hypothetical pipeline routes that the model uses for the oil-spill-trajectory analysis, see Appendix A, Map A.1-4. There are 25 launch areas and 17 pipeline segments considered in the model.

Summer Oil Spills - Barrier Islands and Coastline. A summer spill could impact polar bears coming ashore due to sea-ice retreat or in preparation for denning later in the fall/winter season. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during summer, unless otherwise specified. The particularly important areas during this time period include barrier islands along the coast, as well as the coastline itself. The OSRA model estimates the chance of a large oil spill contacting the barrier islands that are important environmental resource areas to polar bears (Table 4.4.2.6.3-1). Barter Island (ERA95) and Cross Island (ERA93) are particularly important because of the large concentrations of polar bears that are drawn to the islands to feed on bowhead whale carcasses in fall. A large spill has a 7% chance or less of contacting Cross Island and No Name Island within 30 days. There is no difference within 360 days the chance of contact remains at 7% or less. A summer spill has a 5% chance or less of contacting Barter Island, Bernard Spit and Arey Island within 30 days. Again, there is no difference within 60 days, the chance of contact remains at 5% or less. For more information see Appendix A, Tables A.2-65, A.2-66, A.2-71 and A.2-72.

If groups of land segments are considered, the chance of contact from a large spill contacting the U.S. Beaufort Sea coastline within 30 days varies from <0.5% from LA25 to a high of 63% from LA4. The chance of contact is highly variable due to the effects of wind, current, and proximity to shore and depends on the location of a launch area where a large spill could originate (Table A.2-89, Maps A.1-3d and A.1-4). After 360 days, the estimated chance of contact increases to a low of 23% from LA25 to a high of 72% from LAs 2 and 4 (Table A.2-95). The chance of contact from a large spill originating at a pipeline reaching the U.S. Beaufort Sea coastline within 30 days ranges from 1% from PL16 to a high of 59% from PL8 (Table A.2-90). After 360 days, the estimated chance of a large spill contacting the coastline ranges from 36% from PL16 to 69% from PL8 (Table A.2-96).

The estimated chance that a large oil spill originating at a LA would contact the shoreline of ANWR, also an important polar bear denning habitat, within 30 days ranges from <0.5% from 14 launch areas to a high of 51% from LA18. After 360 days, this rises to a range of 1-53%. The estimated chance that a large oil spill originating at a pipeline segment would contact the shoreline of ANWR within 30 days ranges from <0.5% from nine pipeline segments to a high of 45% from PL14. After 360 days, this rises to a range of 1-49% (Appendix A, Tables A.2-89, A.2-90, A.2-95, and A.2-96).

Winter Oil Spills - Barrier Islands and Coastline. The OSRA model estimates the chance of a large oil spill contacting the barrier islands that are important environmental resource areas to polar bears (Table 4.4.2.6.3-2). The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during winter, unless otherwise specified. A large spill has a 1% chance or less of contacting Cross Island and No Name Island within 30 days. There is no difference 360 days after a spill, the chance of contact remains at 1% or less. A large spill has a <0.5% chance of contacting Barter Island, Bernard Spit and Arey Island within 30 days. There is very little difference within 360 days the chance of contact remains at 1% or less. For more information, see Appendix A, Tables A.2-113, A.2-114, A.2-119 and A.2-120.

If groups of land segments are considered, the chance of contact from a large spill at launch areas reaching the U.S. Beaufort Sea coastline within 30 days ranges from a low of <0.5% at three launch areas to a high of 14% at LA18 (Table A.2-137, Maps A.1-3d and A.1-4). The chance of contact from a large spill originating at a pipeline segment reaching the U.S. Beaufort Sea coastline within 30 days ranges from <0.5% at PL16 to a high of 12% at PL14. The estimated chance that a large oil spill originating at a

launch area contacts the shoreline of ANWR within 30 days ranges from a low of <0.5% from seven launch areas to a high of 14% from LA18. The chance that a large oil spill originating at a pipeline segment would contact the shoreline of ANWR within 30 days ranges from a low of <0.5% from two pipeline segments to a high of 12% from PL14 (Appendix A, Table A.2-137 and A.2-138).

Increasing trends in polar bear use of terrestrial habitat in the fall are likely to continue, as sea ice conditions continue to change. We realize that some OCS operations might pose a relatively high chance of contacting polar bear aggregations, depending on their geographic location and if a spill occurred and, therefore, to the polar bear population as a whole. In March 2006, more than 4,790-bbl (200,000 gal) of oil spilled onto the tundra on the North Slope as a result of a leak in a corroded pipeline that went undetected for an extended length of time. As demonstrated by this spill, small, chronic leaks in underwater pipelines could result in large volumes of oil being released under water without detection. If such an event were to occur in offshore waters, there could be major impacts to the polar bear population. If such a spill occurred during winter, the release of oil trapped under the ice during spring breakup would be equivalent to the catastrophic release of the same amount of oil (Amstrup, Durner, and McDonald, 2000). The continued use of new technology, such as the LEOS leak-detection system, can greatly enhance the ability to detect small leaks so they do not become large spills over time. The MMS regulations require spill prevention and equipment monitoring.

Combined Probabilities. Combined probabilities differ from conditional probabilities in that there is no assumption that a spill has occurred. Instead, combined probabilities reflect the chance of one or more large spills occurring and contacting any portion of a particular resource area. Combined probabilities do not factor in any cleanup efforts. For more background, see Appendix A, Section 4.3. The OSRA model estimates the chance of one or more large spill (>1,000 bbl) occurring and contacting any portion of Point Barrow; the Plover area; Thetis, Jones, Cottle or Return islands is <0.5% from 3 days after a spill until 30 days after a spill, when it increases to 1% and remains at 1% from 30 days through 360 days after the spill. The combined probabilities of a large spill (>1,000 bbl) occurring and contacting any portion of Maguire, Flaxman, or Barrier island is <0.5% from 3 days after a spill until 180 days after a spill; the percent chance rises to 1% 360 days after the spill. There is a <0.5% chance of a spill occurring and contacting Cross, No Name, Arey, or Barter islands or Bernard Spit from 3 days after a spill through 360 days after a spill. The combined probability of one or more large spills occurring and contacting coastline of ANWR is 1% from 10-30 days after a spill, 2% 60 days after a spill, 3% 180 days after a spill, and 4% 360 days after a spill.

Chronic Low-Volume Spills. Small or low-volume spills are defined as spills <1,000 bbl. Between 1989 and 2000, there have been 1,178 spills of <500 bbl on the Alaska North Slope. There have been six spills that were between 500 and 1,000 bbl. The total volume of all 95 spills combined was 306,277 gal. or 7,292 bbl (Table A.1-29). An estimated 89 small crude oil spills of <500 bbl could occur during the 20-year oil-production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average crude oil spill size is 126 gal (3 bbl) for spills <500 bbl. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined oil spills could occur during the 20-year oil-production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills could occur during each year over the 20-year production period.

The effects of small-volume spills on polar bears would depend on the location and timing of each spill, as well as the speed and success rate of cleanup efforts, and of efforts to haze bears away from the spill area. If one or more small-volume spills were to occur in close proximity to Bernard Spit or Cross or Barter island in late summer or fall, 60 bears or more could be present (Miller et al., 2006).

Spill-Response Activities. Conditional and combined probabilities do not factor in the effectiveness of oil-spill response activities to large or small spills. Oil-spill responses (cleanup efforts) vary from highly effective in calm, open-water conditions to largely ineffective during unfavorable or broken-ice conditions. The MMS requires that each operator have an approved OSRP prior to the onset of production, and that equipment and trained personnel be available to respond to spills.

In general, oil-spill-response activities include containing the release and spread of oil, recovering oil as quickly as is safely possible, and keeping oil away from areas identified as critical habitat using boom or other resources. Both Cross and Barter island have been identified in spill-response documents and on maps as critical habitat for polar bear (Alaska Clean Seas Technical Manual, 2007). During oil-spill-response activities, oiled carcasses would be collected when feasible, which could lessen the risk of polar bears ingesting oiled prey items. In some circumstances, such as oiled seals or seal carcasses floating in broken ice and in open leads, it would be very difficult to locate and recover carcasses.

Depending on the location of the spill, oil-spill response could take some time to begin. Oil-spill-response equipment is cached in Barrow as well as in Deadhorse, about 150 mi east of Barrow. Hazing may be very effective in the case of small spills or in relatively discrete areas. Oil-spill-response personnel would be expected to work with the FWS on polar bear management activities in the event of a spill. Wildlife response activities could involve hazing bears away from an area; however, once oiled, it is unlikely that an oiled bear would survive.

To adequately protect polar bears and their habitat from the threat of a large oil spill, or chronic small spills, the mitigation measures in place must be adaptable to continued changes in polar bear distribution and habitat use, for example, increasing use of the coastline in late summer and fall. Equipment and trained crews need to be able to respond rapidly to a spill as soon as it is discovered. The effectiveness of oil-spill-response measures will depend largely on the location of the spill, the distances involved, the season, and the weather along the Beaufort Sea coast.

Prey Reduction or Contamination. In the Beaufort Sea, ringed seals may make up as much as 98% of polar bear diet. Polar bear populations are known to decline or increase in relation to prey availability. In the past, numbers and productivity of polar bears have declined in response to declines in ringed seal populations in the Beaufort Sea (Schliebe et al., 2006). Large-scale reductions or contamination of food sources (ringed and bearded seals) could reduce survival and reproductive success of the Southern Beaufort Sea and/or Chukchi Sea populations of polar bears. Small-scale reductions in seal populations are less likely to impact polar bears, because they tend to disperse over large areas in search of prey. However, polar bears are not likely to avoid oiled carcasses, and ingestion of oiled prey is likely to have lethal effects. Oritsland et al. (1981) found that ingestion of petroleum hydrocarbons lead to anorexia and damage to kidneys, liver, and other tissues. The effects of the damage were not apparent for several weeks after ingestion.

Summary of Oil-Spill Effects. We conclude that if an offshore oil spill occurred, a potentially significant impact to polar bears could result, particularly if areas in and around polar bear aggregations were oiled. This is because the biological potential for polar bears to recover from any perturbation is low due to their low reproductive rate (Amstrup, 2000). Based on OSRA analysis, the estimated chance of a large spill occurring over the 20-year life of production is 26% (Table A.1-26). The combined probability of one or more large oil spills occurring and contacting any portion of the Beaufort Sea coastline is <5% within 60 days (Table A.2-160).

The MMS regulations are designed to reduce potential impacts by requiring specific mitigation measures for specific exploration and development activities associated with Lease Sale 209 or 217. However,

prior to commencement of exploration, development, and production activities, proposed activities will be analyzed on a case-by-case basis and effective mitigation measures developed accordingly, based on the latest polar bear population estimates, distribution information, other research results, and the location and timing of the activity. The FWS may impose additional mitigation measures to protect polar bears.

In summary, documented impacts to polar bears to date in the Beaufort Sea by the oil and gas industry appear minimal. Due primarily to increased concentrations of bears on parts of the coast, the relative oil-spill-risk to the population may be increasing. Close cooperation among MMS, the FWS, OCS operators, and oil-spill-response personnel will help to ensure that the level of effect does not increase. Therefore, our overall finding is that Alternative 2, with existing MMS operating regulations and the standard mitigation measures imposed by FWS, is not likely to adversely affect the polar bear.

4.4.2.6.3.4.5. Anticipated Effects from Habitat Loss and Degradation. A temporary loss of polar bear habitat could result from exploration activities. This would have minor effects on the availability of denning habitat and foraging habitat. The level of displacement would depend on the level of exploration occurring and the duration of the activity.

The Proposed Action could increase the footprint of activities ongoing on the North Slope. Permanent habitat loss would be associated with production activities, which are not considered reasonably foreseeable from this lease sale at this time. Critical habitat has not yet been designated for polar bears. This lease sale would add incrementally to the level of exploration currently ongoing on the North Slope, and to temporary losses of habitat for the polar bear and their prey species. We expect the lease sales to have only minor effects on polar bears.

4.4.2.6.3.4.6. Anticipated Effects from Seismic Noise. Polar bears are less sensitive to disturbance from seismic activities than many marine mammal species. However, females in dens, both on sea ice and onshore are at risk to disturbance from any vehicular traffic or noise. Mitigation measures currently in place require industry to locate and avoid polar bear dens. With these mitigation measures in place, we expect only minor impacts to polar bears.

4.4.2.6.3.4.7 Anticipated Effects of Changes in the Physical Environment. Current scientific data is not sufficient to allow an assessment of the contribution of the Proposed Action to long-term trends associated with anthropogenic effects on climate change. At this point, production from these lease sales is considered speculative. Should production occur in the future as a result of these lease sales, it is unlikely to have a profound effect on the level of oil produced or consumed on a world-wide basis. These lease sales are not expected to add to that effect in any consequential way.

4.4.2.6.3.5. Cumulative Effects Under Alternative 2. The anticipated effects of Alternative 2, the Proposed Action, are combined with the anticipated effects of Alternative 1, the no-action alternative, to determine the cumulative effects for this alternative. This cumulative effects analysis assumes that mitigation measures (described in Section 4.4.1.6.3.2) will be in place, and that none of the proposed deferrals are selected. Lease sales 209 and 217 likely would result in an increase in the number of leases in the Beaufort Sea OCS. Given the history to date in the OCS in Alaska, it is reasonable to assume that: (1) many available leases will not be purchased; (2) not all leases purchased will be explored; and (3) that most exploration will not lead to development. Leases would revert to the Federal Government after 10 years, if no development occurs. There may be an initial increase in the number of active leases following a lease sale and a corresponding increase in exploration activities, but there will be a gradual decline in active leases from these sales over time.

Seismic surveys and exploration drilling could continue at existing levels due to a limited number of suitable or specialized vessels for conducting these activities, or they could increase if the operators secure additional vessels and equipment. The NMFS and/or FWS may choose to limit the number of active seismic operations or to limit the operating area in order to decrease impacts to marine mammals, including polar bears. If current equipment constraints hold, no more than two drill rigs could operate in the Beaufort Sea at any one time. Similarly, no more than six seismic-surveying activities could be completed during a season simultaneously in the Beaufort Sea. This level of activity would represent a continuation of the same level of effect as described for anticipated Federal oil and gas activities under the Reasonably Foreseeable and Speculative Future Events (Section 4.2), except that these activities likely would extend further into the future as new leases are granted. While MMS actions likely would result in an incremental increase in sources of potential impacts, required mitigation measures could limit these impacts.

Impacts to polar bears are greatest from ongoing climate changes, sea-ice reduction, and potential changes in prey availability. Impacts from local community travel and subsistence activities are expected to continue at current levels. Impacts from oil and gas infrastructure developments eventually may increase from these lease sales, but it is difficult to predict whether or to what extent this will happen. Disturbances to polar bears in nearshore areas from unrestricted vessel, snowmachine, and low-flying aircraft traffic unrelated to OCS leasing activities, as well as from regulated OCS activities, would continue to have minor effects on polar bears. The greatest source of large, noncrude oil spills would continue to arise from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels, as well as a potential increase in traffic related to OCS exploration, increases the potential for marine accidents, disturbance/displacement and fuel spills, which could result in major adverse effects on polar bears. Continued climate change is likely to result in major adverse effects to polar bears.

In summary, documented impacts to polar bears to date in the Beaufort Sea by the oil and gas industry appear minimal. Close cooperation between MMS, FWS, and OCS operators will help to ensure that the level of effect does not increase. Therefore, our overall finding is that the Proposed Action, if properly mitigated, likely would result in minor effects on the overall level of impacts to polar bear populations and is not likely to adversely affect polar bears.

4.4.2.7. Marine and Coastal Birds.

Summary. In the following analysis, we determined that there likely would be few direct or indirect effects if the lease sales were conducted: there would be a negligible level of effect from vessel presence and noise, aircraft presence and noise, seismic airgun noise, petroleum spills, increased bird predator populations, subsistence hunting, and habitat loss and a minor level of effect from collisions with structures. While the greatest potential for a major level of effect is associated with continuing physical changes in the arctic environment, the lease sales will not result in a direct effect on this impact category. The direct and indirect effects of this alternative were combined with the cumulative effects from Alternative 1 and the resultant levels of effect are the same as those for Alternative 1. Mitigation measures imposed by MMS on future exploration and development activities on existing leases and surrounding waters avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. While MMS-authorized actions could result in a small incremental increase in or longer duration of some activities, the total effect would be proportionately lower when compared to similar, but unrestricted activities in the area.

The following analysis describes the anticipated level of effect for this alternative on marine and coastal birds that most likely would occur if MMS opens the entire lease-sale area (no deferrals) in the Beaufort

Sea. The potential effects are evaluated in consideration of mitigation measures to determine the anticipated effects of selecting the proposed action. As threatened and endangered birds represent a resource group, we address differential effects to key species in Section 4.4.2.7.4.

4.4.2.7.1. Potential Effects to Marine and Coastal Birds. Marine and coastal birds in the Beaufort Sea are subject to the same potential effects described for threatened and endangered birds (Section 4.4.1.6.2.1).

4.4.2.7.2. Mitigation Measures. The potential effects would be moderated by the mitigation measures listed in Section 4.4.1.6.2.2 for prelease seismic surveys, State- and locally-authorized activities, and relevant portions of Stipulation 2 as described in Section 4.4.2.6.2.2 and Appendix F.

4.4.2.7.3. Anticipated Effects Under Alternative 2. The other important factors (timing, residence time and productivity, spatial extent, environmental factors, etc.) considered and the terms used to describe the level of effect are defined in Section 4.4.1.6.2.3. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.2.7.3.1) and cumulative effects (Section 4.4.2.7.3.2).

4.4.2.7.3.1. Direct and Indirect Effects Under Alternative 2.

Summary. While adverse effects on marine and coastal birds from routine exploration activities are possible, mitigation measures designed to avoid and minimize these effects will reduce disturbance impacts to a negligible level of effect. There is a small potential for the loss of a few individuals from several marine and coastal bird species as a result of collisions with offshore structures. Overall, exploration activities resulting from implementation of this alternative would have no more than a minor level of direct or indirect effect on marine and coastal birds.

Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially-viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on marine and coastal bird populations if such a discovery is made and proposed for development in the more distant future. Such production-related activities include habitat losses due to construction of development/production facilities, collisions with certain structures, and the potential for oil spills. Potential habitat losses would displace marine and coastal birds from nesting areas, but nesting habitat is not believed to be limiting these species on the ACP and long-term adverse effects are not anticipated. Mortality of marine and coastal birds during production, including habitat loss, collisions, and accidental spills could represent a major level of effect.

This analysis identifies the anticipated level of effect of implementing this alternative on marine and coastal birds of the Beaufort Sea. These anticipated effects consider mitigation measures (identified above) and other important factors (timing, residence time and productivity, spatial extent, etc.) described in Section 4.4.1.6.2.3. We also defined the terms used to describe the anticipated level of effect in Section 4.4.1.6.2.3. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.2.7.3.1) and cumulative effects (Section 4.4.2.7.3.2). As marine and coastal birds represent a resource group, we address differential effects to each species in Section 4.4.2.7.4.

4.4.2.7.3.1. Direct and Indirect Effects Under Alternative 2.

4.4.2.7.3.1.1. Anticipated Level of Effect from Vessel Presence and Noise. Oil and gas exploration and development in the Beaufort Sea OCS could result in disturbance to marine and coastal birds. Mitigation measures imposed by MMS on future exploration and development activities avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. Vessel activities associated with the proposed action are anticipated to have a negligible level of effect on marine and coastal birds in the Beaufort Sea.

4.4.2.7.3.1.2. Anticipated Level of Effect from Aircraft Presence and Noise. Low-level aircraft traffic could adversely affect marine and coastal birds by: (1) displacing adults and/or broods from preferred habitats during prenesting, nesting, and broodrearing and migration; (2) displacing females from nests, exposing eggs or small young to inclement weather or predators; and (3) reducing foraging efficiency and feeding time. The behavioral responses of marine and coastal birds to low-level aircraft flights are varied, but there are some direct observations relevant to marine and coastal birds of the Beaufort and Chukchi seas. Lehnhausen and Quinlan (1981) observed low-flying aircraft disturbing common eider-nesting colonies on barrier islands, flushing birds off their nests in “mass panic flights.” The authors speculate that gulls and jaegers (“...constantly flying over [the colony]”) preyed on the nests while the adults are away, resulting in decreased nesting success. Low-flying aircraft also could impact sensitive species, such as brant feeding and resting in coastal saltmarshes or long-tailed ducks molting in coastal lagoons (Lehnhausen and Quinlan, 1981).

The number of nesting marine and coastal birds that would be exposed to low-level flights associated with OCS oil and gas exploration is low, because the potential direct flight from an airbase to offshore work sites within the OCS would primarily be over coastal waters. Mitigation measures imposed on future exploration activities avoid or minimize adverse effects to marine and coastal birds rearing or staging in the Beaufort Sea. Aircraft activities associated with the proposed action are anticipated to have a negligible level of effect on marine and coastal birds in the Beaufort Sea.

4.4.2.7.3.1.3. Anticipated Level of Effect from Collisions. The MMS cannot assume that recommendations for the design, implementation, and operation of lighting of structures would result in no strikes by marine and coastal birds, particularly long-tailed ducks and common or king eiders. The MMS and FWS both acknowledge that estimating collision mortality is extremely difficult due to a lack of available information. Mitigation measures imposed on future exploration and development activities are believed to minimize collision mortality to marine and coastal birds from oil and gas exploration activities on the Beaufort Sea OCS. The existing level of collision mortality appears low, and even a slight increase above existing levels is not anticipated to result in more than a minor level of effect on marine and coastal birds of the Beaufort Sea.

4.4.2.7.3.1.4. Anticipated Level of Effect from Petroleum Spills. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect large numbers of marine and coastal birds because of a spill’s ability to spread and persist. Exposure of marine and coastal birds is expected to result in the general effects reviewed in Section 4.4.1.6.2.1.4. This analysis assumes that all birds contacted by oil would not survive and that secondary effects may cause impaired physiological function and production of fewer young. A large spill from a well blowout is described as a very unlikely event in and no large oil spills are assumed to occur during exploration activities (Appendix A, Section 1.1.4).

It is important to remember that a large spill event associated with OCS oil and gas activities would likely only occur during the production phase, when volumes of oil or gas product is being moved to production

facilities in the existing facilities at Kuparuk or Prudhoe Bay. Section 4.4.1.6.2.1.4 (Anticipated Level of Effects to Threatened and Endangered Birds: Petroleum Spills) describes the basis for concluding that oil or gas production resulting from the proposed lease sales is considered speculative and production effects are not considered reasonably foreseeable. Such a commercial discovery warranting production has not been identified or proposed for development. In other words, the MMS can describe how a large spill could have a major level of effect on some marine and coastal bird populations; a spill from production activities is not considered a reasonably foreseeable future event.

The MMS models large spills in order to estimate the chance that a large spill could contact important environmental resource areas and then analyzes the potential effects from oil spills to determine which resource areas would have the highest chance of contact. In the following sections, we evaluate the vulnerability of certain groups of marine and coastal birds to oil spills (oil-spill analysis), then we describe the effect of disturbance from oil cleanup activities, the effects of prey reduction or contamination, and the anticipated effects of that mortality on these bird populations.

Oil-Spill Effects Analysis. The potential for spills to contact marine and coastal birds in the Beaufort Sea was previously described in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS 2003a). Due to small adjustments in the environmental resource areas (size/shape), changes in lease area and other model refinements, we have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are much the same as those for the previous lease sale in the Beaufort Sea.

The following paragraphs present conditional and combined probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting or occurring and contacting many of the best known habitats that are important to marine and coastal birds. Given the wide variety of bird species that use the proposed lease-sale area and factoring in continuous changes in prey abundance and other biotic and abiotic factors that affect bird distribution, it is possible that large aggregations of birds could have a chance of a large spill contacting from anywhere in the lease-sale area. For instance, short-tailed shearwaters and some auklet species occur during the summer throughout the lease sale area, but a large spill could contact large numbers of them or none at all, depending on the location of the spill and location of the birds at the time of the spill.

For many marine species, it is not possible to assess the chance of contact with oil with a high degree of confidence. Conditional probabilities are based on the assumption that a large spill occurs (see Appendix A). Combined probabilities, on the other hand, factor in the chance of one or more large spills occurring and then contacting an environmental resource area. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the resource areas being discussed within 180 days during summer or winter (Appendix A, Tables A.3-35 or A.3-59). The resource area references and locations are found in Appendix A, Table A.1-14, Maps A.1-2a through 2e and the launch areas and pipeline segments are found in Appendix A, Map A.1-4 (Beaufort Sea). An environmental resource area can represent an area important to one or several species or species groups during a discrete amount of time.

Conditional Probabilities. This section describes the conditional probabilities estimated by the OSRA model of a large oil spill in the Beaufort Sea contacting specific environmental resource areas that are important to marine and coastal birds. No large oil spills are assumed to occur during exploration activities.

The spill rate of large platform and pipeline spills during production is 0.58 (95% confidence interval = 0.26-0.78) per billion barrels of oil with a 26% chance of one or more large spills occurring over the 20-year production life of the project (Appendix A, Table A.1-26). For the development and production

phases, the fate and behavior of a 1,500-bbl spill from a platform and a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller area (181 km²) (Appendix A, Table A.1-6) than a 4,600-bbl spill (320 km²) (Appendix A, Table A.1-7) after 30 days. The OSRA uses the center of the spill mass as the contact point, so the chances of either size spill contacting specific environmental resource areas would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed from this point on.

A 4,600-bbl spill could contact environmental resource areas where marine and coastal birds may be present (Appendix A). Approximately 40% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km².

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting marine and coastal bird habitats (ERAs 1, 2, 8, 9, 10, 14, 15, 17-19, 64, 65, 68, 69-73, 77-79, and 96). Conditional probabilities are based on the assumption that a large spill occurs (see definition and applications, Appendix A).

Summer Spill. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during summer within 30 days, unless otherwise specified. The OSRA model estimates that the chance of a large oil spill contacting any coastal or offshore environmental resource area important to marine and coastal birds (Table A.1-14) ranges from <0.5-52% from launch areas (Table A.2-65) and 44% from pipeline segments (Table A.2-66), depending on the distance between launch points/pipelines and resource areas (Maps A.1-4 and A.1-2a through e). If groups of land segments are considered, the OSRA model estimates the highest chance of a large spill contacting the U.S. Beaufort Sea coastline is 63% from LAs 2 and 4 (Table A.2-89, Map A.1-3d) and 59% from PL8 (Table A.2-90). The OSRA model estimates a large spill has a 28% (from LA18) and 23% (from PL14) chance of contacting the Canadian Beaufort Sea coastline.

If only lagoons and other coastal areas and nearshore waters are considered, there are 22 instances where the chance of a large spill originating from any launch area reaching a coastal lagoon/coastal area is >10%. These include Point Barrow/Plover Islands (ERA2; range 11-52% from LAs 1-6); Harrison Bay (ERA68; range 11-33% from LAs 6-10); and Demarcation Bay/Offshore (ERA79; range 13-42% from LAs 18-20) (Table A.2-65) within 30 days. This suggests a relatively high percent chance of a large spill contacting and assumed mortality for long-tailed ducks (the most abundant species that gather in aggregations of several thousands to molt in central Beaufort lagoons) and common eiders that nest on barrier islands. The OSRA model estimates the chance of a large spill contacting Simpson Lagoon (ERA71) and Harrison Bay (ERA69) areas, for example, where large numbers of long-tailed ducks, in addition to king eiders and other species occur, range up to 11% and 36%, respectively (Table A.2-65). As noted, this analysis is only for purposes of modeling and to determine which areas would be at highest chance of contact; the foregoing percent chances of contact assume that a large spill occurs.

If other groups of land segments are considered, the chance of contact from a large spill at easternmost LA18 reaching several areas of concern ranges from <0.5% for the Kendall Island Bird Sanctuary in the Mackenzie River Delta to as much as 51% for the U.S. Beaufort Sea coastline (Table A.2-89, Map A.1-3d). Thus, the potential for contacting large numbers of postbroodrearing snow geese that nest in the Kendall Island Bird Sanctuary is not substantial. The highest chance of a spill originating from LA18 and contacting Ivvavik National Park and the rest of the Canadian Beaufort Sea coastline is 28% and 51%, respectively (Table A.2-89).

The coastal resources of the Arctic National Wildlife Refuge warrant particular attention. The chance of a large spill contacting the Refuge's coastline ranges from 12%-51% from LAs 15-20 immediately adjacent to or offshore of the Refuge (Table A.2-89; Maps A.1-4 and A.1-3c). This suggests that large-scale losses of migrating long-tailed ducks (abundant during molt), common eiders (an abundant migrant), king eiders (an uncommon migrant), and numerous individuals of several shorebird species from a hypothetical large spill could occur.

Winter Spill. The following discussion summarizes the results for LAs 1-25 and PLs 1-17 during summer within 180 days, unless otherwise specified. A 180-day period is used in this analysis, because it allows an adequate time period for most winter spills to overlap with the summer open-water period. If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

The OSRA model estimates a <0.5-30% chance that a large spill originating at launch areas will contact environmental resource areas important to marine and coastal birds within 180 days during winter, assuming a spill occurs, and a <0.5-32%, from pipeline segments (Appendix A, Table A.2-117 and A.2-118). The highest chance occurs from PL9 to ERA68, Harrison Bay, which has a 32% chance of contact. The highest chance of a large spill contacting from launch areas occurs to ERA2, Point Barrow/Plover Islands from LA2 (Appendix A, Table A.2-117). The OSRA model estimates the chance that a large spill originating from adjacent LAs 1-6 would contact this same environmental resource area range from 10-20%. The chance of contact tend to be highest where the OSRA model's launch areas or pipeline segments and the environmental resource area are in close proximity to or overlap each other (Appendix A, Table A.2-117/118, maps).

Most postbreeding birds move offshore and then migrate west towards the Ledyard Bay Critical Habitat Area (ERA10). The OSRA model estimates a large spill originating from any launch area or pipeline segment has a <0.5% chance of contacting the ERA10 during winter, melting out in spring. On an annual basis, a large spill originating from any launch area or pipeline segment has a <10% chance of contacting any resource area important to marine and coastal birds in the adjacent Chukchi Sea within 180 days (Appendix A, Table A.2-10).

Many sea ducks must stage offshore in the spring if their breeding habitats are unavailable. The spring lead system (ERA19) is used by nonlisted eiders and other sea ducks during spring. The highest percent chance of contact from a launch area occurs to ERA19, the spring lead system (April-June), which has a 14% chance of contact from LA1 and 11% from PL1 (Appendix A, Table A.2-118). The chance of contact in this environmental resource area is highest, because the OSRA model's launch areas or pipeline segments and the resource area are in close proximity to or overlap each other (Appendix A, Table A.2-117/118, maps).

Combined Probabilities. Combined probabilities are defined in Appendix A (Section 4.3). Combined probabilities differ from conditional probabilities, in that they do not assume that a spill has occurred and consolidate nonuniform weighting of launch probabilities into one unit probability. The chance that one or more large spills would occur is multiplied by the areawide chance that a large spill would contact a particular environmental resource area to estimate a combined probability that both would occur simultaneously.

The combined probability of one or more large spills occurring and contacting a resource area important to marine and coastal birds within 30 days is $\leq 1\%$ (Table A.2-157). While more development may be expected to occur in the vicinity of Prudhoe Bay because of the proximity to primary support facilities,

the combined probability of a summer spill contacting resource areas important to marine and coastal birds offshore of this area within 30 days does not exceed 1%.

Chronic Small Spills. Small or low-volume spills are defined as <1,000 bbl. The average crude oil spill size is 126 gal (3 bbl) for spills <500 bbl. An estimated 89 small crude oil spills would occur during the 20-year oil production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average refined-oil spill size is 29 gals (0.7 bbl), and an estimated 220 refined oil spills would occur during the 20-year oil production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur each of the 20 years of production.

It is unknown how many small spills or what total volume would reach areas used by marine and coastal birds. Chronic low-level spills are not modeled by the OSRA but could adversely affect marine and coastal birds. Although difficult to state with any certainty, a small spill in close proximity to concentrations of marine and coastal birds could result in adverse impacts to pelagic species that tend to forage in dense concentrations. Given the wide distribution of pelagic seabirds, a spill may contact tens of thousands of pelagic birds, if they are foraging in dense concentrations near the spill site or could completely miss them, if they are concentrated in another area. Depending on the chronic nature of small spills, this situation could occur repeatedly.

The location of these small-volume spills would be an important factor in assessing impacts. While it is not possible to predict where these spills might occur given the large lease-sale area, important areas known to receive frequent use such as Peard Bay and Kasegaluk Lagoon could be impacted. Such areas are considered “hot spots.” The bird activity in these areas fluctuates widely based on the time of year and, for many shorebirds, can vary greatly from day to day. For shorebirds in this area, a spill could impact tens of thousands of birds or very few, depending on the time of the spill and the persistence of the oil and its effects.

Spill-Response Activities. None of the conditional or combined probabilities factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil exploration or production.

Activities such as hazing and other human activities (vessel and aircraft traffic) could impact marine and coastal birds. Hazing may have limited success during spring, when migrants occupy open-water ice leads. The hazing effect of cleanup activity or actively hazing birds out of ice leads that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. Cleanup activities in leads during May and open water in July through September are likely to affect nonlisted eiders.

The presence of large numbers of cleanup workers, boats, and additional aircraft is likely to displace marine and coastal birds from affected offshore, nearshore, and/or coastal habitats during open-water periods for one to several seasons. Although little direct mortality from cleanup activity is likely, predators may take some eggs or young while females are displaced off their nests if located near a site of operation. Disturbance during the initial season, possibly lasting 6 months, is expected to be frequent in some areas. Cleanup in coastal areas late in the breeding season may disturb small flocks of flightless broods and some may be displaced from favored habitats, expending energy stores accumulated for molt/migration. Survival and fitness of individuals may be affected to some extent, but this disturbance likely would not result in more than minor level of effect. Again, this assumes that a spill occurs and that an area important to these birds is affected when they are there.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with FWS and State officials on wildlife management activities in the event of a spill. In an actual spill, the two aforementioned groups would most likely have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on birds. As a member of the team, FWS personnel would be largely responsible for providing critical information affecting response activities to protect marine and coastal birds in the event of a spill.

Oil-spill-response plans do not typically spell out specific wildlife response actions. Oil-spill-response plans typically identify the resources at risk and refer to the appropriate tactics. The response contractor also can contract with other response organizations to augment animal hazing and response activities. The response contractor would be expected to have an inventory of bird scare devices in addition to the Breco buoys (air cannons, guns, vessels, pyrotechnics, and visual devices) to deter birds from entering the spill area and would be assumed to cycle their use to ensure that the birds do not habituate to their effect.

For purposes of evaluating the potential impact of a large spill on marine and coastal bird species, oil-spill response in the Beaufort Sea is assumed to be ineffective due to the unpredictability of response time, proximity of the launch site(s) to bird habitats, certain environmental conditions (e.g., broken ice), and the large number of birds that could be impacted in a brief time period (<36 hours).

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce survival or reproductive success of the portion of populations occupying or nesting in the local area affected. This generally is not likely to affect a large proportion of marine and coastal bird populations, because most species exhibit a dispersed breeding distribution. However, it could be more serious if these populations are experiencing a population decline or were restricted to specific foraging habitats. Lowered food intake may slow the completion of growth in young birds, the replacement of female energy reserves used during nesting, and energy storage for migration of all individuals. Effects during seasonal migration could be greater, because birds are more likely to occur in flocks and require high levels of energy intake. However, the contamination of some local habitat areas is not likely to affect a large proportion of the regional bird populations, because they are likely to have access to alternative foraging habitat similar in appearance and with similar prey organisms present that is widely distributed in the region (for details, see USDO, MMS, 2002:Section III.C.2.c).

Anticipated Mortality from an Oil Spill. Most marine and coastal birds (waterfowl, shorebirds, sea birds) essentially are absent from the Beaufort Sea from late October to early June. During spring migration, many migrant waterfowl arrive at the nesting areas via overland routes; thus, few of these are likely to occupy leads offshore where they would be vulnerable to oil. King eiders, however, occupy offshore spring leads in substantial numbers, and loons and several duck species are common in nearshore leads and open water off river deltas. Other species returning to the breeding grounds in the spring often encounter sea ice in offshore areas and must stage in the Chukchi Sea before heading overland to nest sites. Many of these birds congregate in the spring lead system, the only open water available.

Several species use the open waters of the Beaufort Sea for provisioning chicks, including loons, guillemots, and puffins. Postbreeding birds move to coastal areas for molting, staging, or broodrearing. Molting or other flightless birds are particularly vulnerable to oiling because of their limited mobility and the amount of time they spend in the water or in restricted habitats (i.e., coastal lagoons). If a large oil spill occurs during summer or fall periods when molting, staging, or migrating waterfowl, seabirds, and shorebirds occupy open-water marine habitats, a highly variable proportion of their ACP populations could be vulnerable to oil in the Beaufort Sea. The chance of contact is lowered by species being

concentrated in relatively few scattered flocks during the brief period present (Stehn and Platte, 2000:Table 1; Fischer, Tiplady, and Larned, 2002). However, some flocks may be relatively large (mean sea duck-flock size in nearshore areas = 11-34 individuals; in offshore areas, 6-22 individuals; Fischer, Tiplady, and Larned, 2002), and more contact by a large oil spill could result.

Flocks foraging inside the barrier islands (approximately 50% of the coastline has adjacent islands) are protected to some extent from oil-spill contact. Bird mortality associated with an oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use and stage of annual cycle at the time of contact (e.g., molting versus nonmolting).

Aerial surveys conducted in the Harrison Bay to Mikkelsen Bay area in 1999 and 2000 by Fischer, Tiplady, and Larned (2002) and Stehn and Platte (2000) recorded large numbers of about 20 bird species distributed along the shoreline and seaward to about 60 km (37 mi). Estimates of oil-spill mortality for that portion of the coastal plain population occupying this marine area after nesting were calculated using a model that simulated oil-spill movement over time. In addition to the necessity of assuming a large oil-spill would occur, the authors stated that the predictive value of their model was constrained by the incorporation of a number of important assumptions that contribute to the uncertainty of final model estimates of numbers of birds exposed to oil. These assumptions include: (1) errors inherent in estimating numbers of birds present in or passing through a prescribed area during aerial surveys performed at one point in time; (2) no consideration of turnover rates or duration of time a bird spends on the water at a specific site or movements during the period a spill was present; (3) the possibility that the areas sampled on limited surveys do not accurately represent all areas occupied by each bird species; (4) assumption of uniform rather than clumped bird distributions; and (5) limitations of the bird density/oil-spill-trajectory overlay analysis that made the final estimates of numbers of birds exposed to oil less certain. Together, these have considerable potential to influence the number of deaths predicted to result from the oil-spill scenarios analyzed, and indicate the difficulty of determining the actual levels of mortality. However, even if the model lacks precision, the relative magnitudes and patterns of exposure of birds to oil calculated by the model should have application for the management and protection of birds using the Beaufort Sea area.

Long-tailed ducks were the most abundant species found in the nearshore or offshore Beaufort Sea area during these surveys (i.e., up to 37,792 estimated to be present during one survey period), followed by king eiders (19,842), scoters (4,814), common eiders (3,300), glaucous gulls (2,478), and Pacific loons (764). Using average estimated bird-density calculated from these values, and average severity of spill-trajectory paths (i.e., numbers of birds exposed to oil averaged across all possible spill paths and bird densities) and, thus, exposure of birds to oil, the FWS model estimated, for example, that at average bird densities and severity of oil-spill movement, an average of 1,443 long-tailed ducks, 232 king eiders, 147 scoters, 159 common eiders, 217 glaucous gulls, and 23 Pacific loons could be exposed to a large spill (5,912 bbl) within 30 days in July (Stehn and Platte, 2000). In August, comparable exposure values were 2,062 long-tailed ducks, 8 king eiders, 22 scoters, 125 common eiders, 72 glaucous gulls, and 9 Pacific loons.

These values may represent conservative estimates for potential mortality during the molting period of long-tailed ducks and common eiders, because some proportion would be unable to avoid a spill by flying away. Also, substantial numbers of birds migrating westward from eastern localities could stop temporarily and join those molting or staging in a given area, thereby increasing the numbers that could be exposed to a spill there; in each successive area to the west, this effect could be increased as more birds join the westward migration stream. Estimates of maximum mortality, calculated from the interaction of higher bird densities and spill movements that expose larger numbers of birds to oil, are 4-19 times as large as the mean values. Also, many individuals of several species remain in the Beaufort Sea beyond the date of the last of the Fischer, Tiplady, and Larned (2002) and Stehn and Platte (2000)

surveys. In fact, only data that allow determination of waterbird densities are useful for making such mortality estimates, using the MMS oil-spill-model estimates of area covered by a spill.

Prior to the migration period, it is reasonable to assume that offshore densities would dictate the number of individuals exposed to a spill and not the larger number passing through during migration. During migration periods, potentially much greater mortality could occur, as new migrants enter the spill area. However, unless migrant sea ducks alight on the water during migration, they are not particularly susceptible to oiling. In addition, a spill in a particular area during summer would not necessarily move far enough to substantially affect those birds moving offshore from nesting areas much farther to the west, but it could oil migrants from the east. For example, a spill in the Prudhoe Bay area probably would not affect a substantial proportion of birds that nest on the western coastal plain, but it would be expected to potentially affect those flying across the Beaufort Sea from Canada and eastern Alaska.

The MMS estimates that a 4,600-bbl oil spill in the Beaufort Sea would occupy a discontinuous area (i.e., oil assumed to sweep over the entire spill area, but at any given moment would appear as a series of separate patches of oil) of about 320 km² after 30 days (Table A.1-6). This suggested that, for example, using the bird densities in Stehn and Platte (2000) for the central Beaufort area, between 773 and 5,372 long-tailed ducks along some nearshore lagoon areas could be contacted and, in areas east of Mikkelsen Bay, a spill could contact up to 23,600 molting individuals. Other species with smaller numbers dispersed in this area are likely to experience lower mortality from a spill, for example: 176 king eiders, 91 scoters, 568 common eiders, 487 glaucous gulls, and 17 Pacific loons. The model also predicted about 49 km of coastline would be oiled as a result of a spill of this size, suggesting that hundreds to low thousands of shorebirds that pause along the coast during migration potentially could be exposed to beached oil (Larned et al., 2001).

The mortality of several thousand long-tailed ducks would be considered a major effect on the regional population, regardless of whether the recent population index is 89,403 and is undergoing a significant decline (Mallek, Platte, and Stehn, 2007) or 27,418 and with a declining trend (Larned, Stehn, and Platte, 2006) during annual surveys conducted annually about 2 weeks earlier. If the results of the surveys accurately reflect the current population situation, recruitment would not replace a portion of the loss within several generations and recovery would not be expected until the population stabilizes or begins to increase.

The recovery period required for a loss from the suite of species typically occupying the nearshore and offshore Beaufort Sea of up to about 10,000 individuals is difficult to estimate, because species will recover at different rates. Most species with low reproductive rates or population levels (i.e., loons, common eider, black guillemot) are not likely to suffer high mortality as a result of an oil spill, because they are not abundant in the proposed the sale area and do not occur in large feeding flocks, although any losses would be recovered slowly due to relatively low reproductive rates. In the case of king and common eiders, because they have experienced substantial losses over the past several decades, high levels of mortality would represent a major level of effect. Stehn and Platte (2000) however, concluded that king eider, and scoters were least likely to have a high proportion of their populations exposed to oil because of their widespread distribution or tendency to occur farther from the spill source.

By comparison, the relatively small losses of most species, other than the long-tailed duck, likely to result from an oil or fuel spill in the Beaufort Sea may be difficult to separate from natural variation in population numbers. This has been found for other waterbird populations under similar circumstances (for details, see USDO, MMS, 2002: Section III.C.2.a(2)). Regardless of the factors involved in causing mortality, complete recovery of the ACP populations of some species (such as red-throated loons and shorebirds) from even small losses in the proposed Beaufort Sea lease area would not occur until their populations stabilize or begin to increase (Larned, Stehn, and Platte, 2006). Recruitment of individuals

into the population under such circumstances is likely to be low and losses from spill mortality, intensified by low productivity or lowered survival of any age groups, is likely to increase the length of time required for recovery to former population levels. Also, if additional mortality increases the rate of decline, the population presumably would decrease to a lower level over a given interval and, thus, it should take the population longer to recover to a specified former level (i.e., delay recovery) at a given rate of increase.

The most recent surveys of common eiders along barrier islands of the Arctic Coastal Plain indicated an increasing long-term population trend (Dau and Larned, 2007). Of major species surveyed by Larned, Stehn, and Platte (2008), long-term significant growth rates were observed for arctic terns, red-breasted merganser, greater scaup, white-winged scoter, snow goose, greater white-fronted goose, black brant, and tundra swan. The king eider population index was significantly positive (Larned, Stehn, and Platte, 2008). Nonsignificant upward trends are displayed by the yellow-billed loon and snowy owl. Population indices that appeared to remain level were observed for Sabine's gull, Canada goose, Pacific loon, jaegers, glaucous gull, and the northern pintail (Larned, Stehn, and Platte, 2008). The red-throated loon and general shorebird populations appeared to be declining at a significant rate. When a population is declining, the point at which recovery from any oil spill or other mortality associated with oil and gas development begins will be delayed until the species recovers from its decline.

Summary of Spill Effects. The results of this analysis are much the same as those for the previous multiple lease sales in the Beaufort Sea. Exploration activities present few threats from spill events. A hypothetical large spill, following development and production, currently not considered reasonably foreseeable, could affect marine and coastal bird populations in nearshore coastal areas during the postbreeding season. Anticipated mortality associated with these modeled events could represent a moderate proportion of some populations (Stehn et al., 2006). Consequently, consistent with the previous lease-sale analyses, the likelihood of such an event occurring, combined with the uncertainty of the location of the spill, and the seasonal nature of the bird resources inhabiting the area, make it improbable that a large summer oil spill would contact large numbers of marine and coastal birds. The birds are present in the area for 3-5 months out of the year. Even if a bird or flock were present in the vicinity of an oil spill, it might not be contacted by the oil due to avoidance behavior, ice conditions or weather patterns. Furthermore, MMS requires companies to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment. While oil-spill contact with migratory birds has some potential for large-scale mortality, one must consider the low probability of a large spill occurring coupled with a variety of other factors that would need to occur simultaneously for this mortality to occur. The MMS concludes that it is highly unlikely that more than a negligible level of effect on marine and coastal bird populations will result from oil spills within the Beaufort Sea.

Chronic low-level spills are not modeled by the trajectory analysis but could adversely affect a moderate number of marine and coastal birds. Although difficult to state with any certainty, a small volume spill in close proximity to a large dense flock of some of the more common species could result in mortality to perhaps several hundred birds, maybe more. Depending on the chronic nature of small spills, this situation could occur repeatedly.

If a commercially viable resource discovery is made and is considered for development, MMS must complete Section 7 consultation with FWS on a production plan. As with the Sale 193 final EIS (see Information to Lessees, Appendix F of this EIS), "...a future project would not be authorized by MMS if it results in jeopardy or adverse modification of designated critical habitat as determined by FWS." The MMS believes that this condition will help industry incorporate stringent spill-prevention measures into their plans that not only avoids the risk of population-level effects on ESA-protected species in the Beaufort Sea but also other marine and coastal birds species that occur there.

4.4.2.7.3.1.5. Anticipated Level of Effect from Increased Bird Predator Populations.

Increased predator populations would arise only from the construction of development and production facilities, which are not considered reasonably foreseeable at this time. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. While there could be a small incremental increase in the total number of structures or facilities that could be used by bird predators, such as ravens or foxes, these facilities would not be constructed or operated in a manner that would support bird predators.

A lease stipulation (requiring that new infrastructure would avoid the artificial enhancement of predator populations) has recently been implemented for the Liberty project and is anticipated to be implemented for future developments associated with Federal leases. Implementation and enforcement of a leasing stipulation could be expected to minimize any effects of increased predator populations resulting from Federal actions in the OCS. For this reason, a negligible level of effect on marine and coastal birds from increased predator populations is anticipated.

4.4.2.7.3.1.6. Anticipated Level of Effect from Subsistence-Hunting Activity. Increased subsistence-hunting activity could arise only from the construction of development and production facilities, which are not considered reasonably foreseeable at this time. If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. While there would likely be an incremental increase in the total number of gravel roads that could be used by bird hunters, it is unknown whether increased access would result in an increased harvest of marine and coastal birds. The MMS must assume that the harvests of marine and coastal birds are fully compliant with existing laws and a negligible level of effect is anticipated.

4.4.2.7.3.1.7. Anticipated Level of Effect from Habitat Loss. Small amounts of temporary habitat loss of marine and coastal bird migration habitats could occur from drilling exploration or delineation wells into the seafloor. Birds could be displaced from the immediate area of the drilling activity. As some of these areas could be in marine and coastal bird habitats, these temporary modifications or displacement could be considered a minor level of effect.

Permanent habitat loss would arise only from the construction of development and production facilities (offshore platform, an undersea pipeline, a pipeline landfall to an onshore base, and a pipeline linking to existing infrastructure), which are not considered reasonably foreseeable at this time. Direct impacts to marine and coastal bird nesting habitat could arise from the facility footprint. The MMS can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but they were estimated (Table 4.4.1.6.2-1). Overall, these developments are estimated to have a direct footprint of 3.41 km² (845 acres). The zones of secondary influence from development facilities have an estimated collective areal extent of 33 km² (8,327 acres) (Table 4.4.1.6.2-1).

If production eventually is proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to marine and coastal birds in the Beaufort Sea. While there could be an incremental increase in the total number of acres of marine and coastal bird habitat eliminated, nesting habitat has not been identified as a factor limiting these populations. Indirect habitat losses could result from marine and coastal bird not using habitats near sites of industrial activity.

4.4.2.7.3.1.8. Anticipated Level of Effect from Seismic Airgun Noise. Seismic activities are used to locate and delineate potential oil and gas resources. Most seismic activity on land is conducted during winter, when marine and coastal birds are absent. Exploratory/delineation drilling, seismic work, and related support activities are typically conducted from vessels during the ice-free, open-water period.

The important mitigation measures that would be imposed to protect marine and coastal birds are listed in Section 4.4.1.6.2.2, Mitigation Measures. The MMS will impose the mitigation measures on future exploration and development activities to avoid or minimize adverse effects to birds in the Beaufort Sea. A negligible level of effect from seismic activities is anticipated.

4.4.2.7.3.1.9. Anticipated Level of Effect from Changes in the Physical Environment.

Changes in the physical environment are believed to result from climate changes superimposed on the vagaries of regional weather patterns. These long-term trends are outside the influence of the proposed action. The argument that potential sources of energy that could be generated from Arctic OCS oil or gas development contributes to further changes in the physical environment fails to recognize that America has large energy needs, and energy not produced from the Alaska OCS would continue to be replaced by foreign imports. Overall, as America uses these fuels, it affects worldwide CO₂ levels/climate change to the same extent, regardless of their source. The proposed action would have a negligible level of direct effect on greenhouse emissions.

4.4.2.7.3.2. Cumulative Effects Under Alternative 2. The anticipated effects of the proposed action are combined with the anticipated effects of the no-action alternative to determine the cumulative effects for this alternative. Lease sales 209 and 217 likely could result in a small increase in the number of leases in the Beaufort Sea OCS. Some of the existing leases will not be explored, and some were explored and will not be evaluated further by the time the lease lapses. While there may be an initial increase in the number of active leases following the proposed sales, there would be a gradual decline in active leases over time.

Seismic surveys and exploration drilling could continue at near existing levels due to a limited number of suitable or specialized vessels for conducting these activities. No more than two drill rigs could operate in the Beaufort Sea at any one time. Similarly, no more than six seismic surveying activities could be completed during a season, which is an unrealistic number because there are not six seismic-surveying vessels available. It is more reasonable to assume that no more than three seismic surveys could be completed simultaneously in the Beaufort Sea. This level of activity would represent a continuation of the same level of effect as described for anticipated Federal oil and gas activities under the Reasonably Foreseeable and Speculative Future Events (Section 4.2), except that these activities likely would extend further into the future as new leases are granted. While MMS-authorized actions could result in a small incremental increase in some sources of potential impacts (e.g., vessel and aircraft traffic), required mitigation measures would limit these sources to proportionately fewer impacts compared to other unrestricted sources of impact in this area.

Impacts to marine and coastal birds from continued community and oil and gas infrastructure developments, collisions with community and oil and gas infrastructure facilities, and disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic—all unrelated to OCS leasing activities—would continue to have a moderate level of effect on marine and coastal birds. The greatest source of large noncrude oil spills would continue to arise from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels dramatically could increase the potential for marine accidents and large fuel spills, which could result in a major adverse level of effect on marine and coastal bird populations in the Beaufort Sea. Continued climate change is likely to result in a major level of effect to some populations of marine and coastal birds.

4.4.2.7.4. Species-Specific Level of Effect. As the anticipated cumulative effects under the proposed action are the same as those determined for Alternative 1, the species-specific level of effects to marine and coastal birds are the same as those described in Section 4.4.1.7.4.

Mitigation measures imposed on future exploration and development activities would avoid or minimize direct and indirect adverse effects to marine and coastal birds in the Beaufort Sea.

4.4.2.8. Other Marine Mammals.

Summary. This section addresses how marine mammals not currently listed under the ESA that typically occur in the Alaskan Beaufort Sea could be affected by the Proposed Action. All marine mammals are protected by the MMPA. These marine mammals include ice seals (ribbon, ringed, bearded, and spotted seals); the Pacific walrus; toothed whales (beluga and killer whales, narwhal, and harbor porpoise); and baleen whales (minke and gray whales, see Section 3.3.6.2.2). The Pacific walrus and all four of the ice seals have been petitioned for listing under the ESA.

Ringed, Spotted, Ribbon, and Bearded Seals. Ringed and bearded seals are relatively common in the Beaufort Sea. Spotted and ribbon seals are less common. These ice seals are hunted by Alaskan Natives and coexist with numerous aircraft operations and an increasing volume of vessel traffic. Existing levels of oil and gas activities, including seismic surveys, continue to have negligible effects on ice seals; however, ongoing changes to the physical environment from climate change have the greatest potential to result in major effects to ice seals.

Pacific Walrus. Pacific walrus primarily inhabit the Chukchi and Bering seas, but walrus occur regularly in the Beaufort Sea as far east as Kaktovik. Temporary displacement of some walrus could occur as a result of routine exploration activities. Noise associated with seismic activities have the potential to affect pinniped hearing and to cause injuries; however, little is known about specific effects to walrus. Mitigation measures requiring safety zones and exclusion zones are expected to adequately protect walrus from harm. Chronic disturbance or displacement can have moderate effects over time, and disturbance events that cause walrus to stampede from haulouts can cause walrus to be injured or killed from trampling. Calves are particularly at risk. Due to a combination of mitigation currently in place and the low level of walrus use in the Beaufort Sea proposed leasing area, negligible effects to walrus are expected to occur.

Development and production activities could result from leases offered under the proposed lease sales. Effects from each specific production project would be analyzed in order to determine the anticipated effects on the walrus population if such a discovery is made and proposed for development in the more distant future.

The primary impacts to walrus from production-related activities include habitat losses due to construction of development/production facilities, pipelines and the associated infrastructure; and the potential for oil spills. Habitat loss in the Beaufort Sea is expected to have negligible effects on walrus given their current distribution, which is primarily throughout the Chukchi Sea and into the Bering Sea. However, distribution may change as walrus shift their movements in response to declining sea ice and other habitat changes.

Pacific walrus may be increasingly impacted by changes in sea-ice cover. In recent years, walrus have been coming ashore in greater numbers as the sea ice retreats over the Continental Shelf, areas too deep for walrus to forage successfully. Continued declines in the spatial and temporal extent of sea ice may have major impacts on walrus. Continued declines in sea-ice extent may limit resting and calving habitat available to walrus, increase the importance of coastal haulouts, decrease available foraging habitat and increase energetic expenditures as walrus are forced to swim further between feeding and resting areas.

Beluga Whale, Killer Whale, Narwhal, and Harbor Porpoise. Killer whales, narwhals, and harbor porpoises are infrequent visitors to the Beaufort Sea. Beluga whales are much more common, but the population trend is unknown. The annual subsistence harvest of about 186 belugas is expected to continue. Existing effects of various vessel and aircraft activity and Federal and State oil and gas industry activities, including seismic exploration, in the Beaufort Sea are anticipated to have no more than a minor effect on beluga whales. Additional OCS leasing is not anticipated to substantially increase levels of OCS-activities, and associated incremental effects would not be detectable above the current baseline condition. Close cooperation between MMS, NMFS, and OCS-operators will help ensure that no more than a negligible level of effect occurs.

An expected increase in traffic from tourism, research, and shipping would increase the noise in the marine environment and the potential for marine accidents and oil spills. The greatest potential effect to beluga whales would be the unlikely event of a large oil spill occurring within the spring lead system at a time and place when migrating beluga whales could contact fresh oil. The impacts to beluga whale subsistence activities from non-OCS-related vessel traffic are expected to continue at current levels. A major level of effect on beluga whales in the Beaufort Sea could result from changes in the physical environment associated with arctic warming/climate change.

Gray Whale. As per the following analysis, if Lease Sales 209 and 217 were held, effects would be from presence and noise of seismic surveys (2D, 3D, high resolution); vessels; aircraft; drilling and production facility placement and operation and abandonment; petroleum spills; discharges; vessel collision and injury; and physical changes or alteration of habitat. The greatest potential effects may be habitat change resulting from arctic warming, and effects may be beneficial or adverse, remain speculative at this time, and lease sales would not affect arctic warming. Mitigation applied by MMS on and adjacent to existing and new leases to potential exploration, development, and production activities avoid or minimize adverse effects to gray whales in the Beaufort Sea. OCS actions presumably would result in incremental increases in intensity, duration, distribution, and magnitude of activities. Direct and indirect effects under this alternative, combined with the cumulative effects under Alternative 1 (No Lease Sale), result in a minor level of cumulative effects.

The following analysis describes the anticipated effects to non-ESA-listed marine mammals under Alternative 2. We describe the potential effects to marine mammals from a variety of existing sources in Section 4.4.1.8.1. Section 4.4.1.8.2 describes mitigation measures that would avoid or minimize some of adverse impacts. The anticipated effects of implementing this alternative also considers mitigation measures (Section 4.4.2.8.2) and other important factors (Section 4.4.1.8.3). The anticipated effects are separated into direct and indirect effects (Section 4.4.2.8.3.1) and cumulative effects (Section 4.4.2.8.3.2). We defined the terms (negligible, minor, moderate, and major) used to describe the anticipated level of effect or impact effect in Section 4.4.1.8.3.

4.4.2.8.1. Potential Effects to Marine Mammals. The potential effects to non-ESA-protected marine mammals in the Beaufort Sea were described in Section 4.4.1.8.1 and are not repeated here.

4.4.2.8.2. Mitigation Measures. The MMPA requires that human activities have no more than a negligible impact on a marine mammal species. Under the MMPA, it is illegal to harm, harass or disturb marine mammals. In some instances, a company may receive an LOA or IHA from the FWS or NMFS, respectively. An LOA or IHA authorizes the taking of small numbers of marine mammals incidental to a specific activity under specific conditions and as long as all of the conditions of the LOA/IHA are met. The LOAs and IHAs are given only after a thorough review of the proposed activity and generally include specific mitigation and monitoring requirements designed to minimize potential effects on marine mammals. An LOA or IHA will not be given if the activity produces adverse effects that rise above the

level of “negligible impact.” LOAs/IHAs are only available for Level B harassment, defined as “the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.”

The potential effects from MMS-authorized activities would be moderated by the mitigation and monitoring measures (NTLs and ITLs) listed in Appendix F and by the Lease Stipulations (Section 2.2). Under the MMPA, MMS cannot authorize or permit activities that are likely to have more than a negligible impact upon marine mammals. Mitigation and monitoring measures have typically included an adequate OSRP (USDOJ, FWS, 1999), which requires staff training and oil-spill-response equipment on hand, avoiding marine mammals by distances proscribed by NMFS and FWS, having marine mammal observers on board vessels, and avoiding marine mammals by changing vessel course or speed to maintain a sufficient distance from the marine mammals in order to avoid disturbance events, or by avoiding some habitat areas altogether. Any MMS-required measures would be in addition to or superseded by those mandated under an IHA or LOA.

Stipulation 1 proposed in this lease sale includes conducting an annual orientation program for all industry personnel which would include information on appropriate ways to avoid disturbing or interfering with marine mammals. This orientation program educates personnel on minimizing potential disturbances to marine mammals. Notice to Lessees No. 08-A04 clarifies that MMS will not authorize or permit activities that may result in the take (as defined by the MMPA) of any marine mammal, unless the FWS or NMFS has determined that any potential take that occurs incidentally to the proposed activity would result in a negligible impact to the species and the Lessee is in possession of an LOA or IHA. This insures that Lessees are advised to consult with the FWS and NMFS prior to beginning any industry activities in areas that may be used by marine mammals.

4.4.2.8.3. Anticipated Effects from Selecting Alternative 2. In this section, we determine the anticipated level of effect on marine mammals if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. These anticipated effects consider mitigation measures described above. We defined the terms used to describe the anticipated level of effect (negligible, minor, moderate, and major) in Section 4.4.1.8.3. The anticipated effects under Alternative 2 are separated into direct and indirect effects (Section 4.4.2.8.3.1) and cumulative effects (Section 4.4.2.8.3.2).

The following analyses assumed that Lease Sales 209 and 217 likely would result in an increase in the number of leases in the Beaufort Sea OCS but, based on history, some of the leased tracts will not be explored, and some that are explored will not be subjected to further evaluation or development. Because of the limited timing and resources available for open-water seismic exploration and open-water exploratory drilling at active lease locations, these activities are anticipated to continue at near-present levels for the foreseeable future, even if more leases are issued.

4.4.2.8.3.1. Direct and Indirect Effects Under Alternative 2. The principal sources of potential adverse effects to marine mammals in the Beaufort and Chukchi seas include (1) underwater noise; (2) vessel and aircraft disturbance; (3) subsistence; (4) habitat loss; (5) environmental contaminants; (6) petroleum spills; and (7) changes in the physical environment.

4.4.2.8.3.1.1. Anticipated Level of Effect from Underwater Noise. There are four sources of underwater noise that could be affected under this alternative: (1) vessel traffic noise; (2) aircraft noise; (3) seismic-survey noise; and (4) exploration and production drilling, construction, and operational noise.

4.4.2.8.3.1.1.1. Effects from Vessel Traffic Noise. Vessel-related postlease OCS activities on new leases resulting from Lease Sales 209 and 217 could result in a small increase in OCS exploration vessel activity above existing levels in the Beaufort Sea. While there may be more leases, the new leases would not necessarily increase the level of OCS-related vessel activity in the Beaufort Sea. We assume that the increase in vessel traffic noise that could be attributed to the new leases is small.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects from vessel traffic noise to ice-dependent phocid seals are the same as described in Section 4.4.1.8.3.2.2. A negligible level of effect from vessel traffic noise is expected for ice seals under Alternative 2.

Pacific Walrus. Offshore exploration activities taking place in the Beaufort Sea during the open-water season are likely to have negligible effects on walrus. Few walrus are present in the Beaufort Sea, and ramp-up and shut-down procedures are expected to provide adequate protection from the potential for injury to occur from seismic noise. Mitigation measures imposed by MMS and FWS on potential future exploration and development activities would help avoid or minimize adverse effects to walrus in the Beaufort Sea from vessel traffic. Mitigation measures typically have included having marine mammal observers on board and vessels avoiding marine mammals by changing course or speed, or by avoiding some areas altogether. Icebreakers, particularly those transiting through the Chukchi Sea to reach work sites in the Beaufort Sea, could have a minor effect on walrus herds hauled out on ice or in water. Icebreakers and the noise from icebreakers temporarily could displace walrus from resting and foraging sites. Icebreakers temporarily alter habitat, which could benefit walrus by opening up new areas or cause additional stress by breaking up icefloes previously large enough for walrus to haul out on to rest. Effects from these activities in the Beaufort Sea likely would be negligible due to the low numbers of walrus in the Beaufort Sea.

Beluga Whale. Vessel traffic associated with exploration activities taking place in the Beaufort Sea OCS during the open-water season is likely to have negligible effects on beluga whales, because mitigation required in an IHA issued by NMFS on future exploration and development activities using vessels would avoid or minimize adverse effects to beluga whales. These measures typically have included having marine mammal observers on board vessels and avoiding marine mammals by changing course or speed, ceasing certain activities when belugas are present, or by avoiding areas where belugas concentrate.

Gray Whale. Temporary and nonlethal effects to gray whales, such as displacement and disturbance from vessel traffic associated with routine exploration, seismic, and drilling activities are anticipated. Potential gray whale injury or mortality of very few individuals is not anticipated to occur from whale-vessel interaction and collision associated with routine exploration activities. A negligible level of effect on the productivity, recruitment, fitness, and survival of individuals or the populations of gray whales is anticipated. Icebreakers introduce noise levels to the marine environment at greater levels than vessels not engaged with the high-intensity power needed for ice management. Few gray whales are likely to be in ice-covered waters when icebreakers would be operating. A negligible level of effect is anticipated.

4.4.2.8.3.1.1.2. Effects from Aircraft Noise. Aircraft-related postlease OCS activities on new leases resulting from Lease Sales 209 and 217 could result in a small increase in exploration-related aircraft activity above existing levels in the Beaufort Sea. While there may be more leases, the new leases would not necessarily increase the level of OCS-related aircraft activity in the Beaufort Sea. We assume that the increases that could be attributed to the new leases would be small, and that mitigation measures imposed by MMS and conditions of an IHA/LOA issued by the NMFS/FWS would reduce the effects from these activities. For example, aircraft associated with OCS activity typically are required to avoid walrus haulout areas by a minimum of 0.5 statute miles and a minimum altitude of 1,500 ft, unless

weather conditions make maintaining this distance or height restriction unsafe for pilot and crew. Avoidance of walrus by these minimum distances would reduce the risk of disturbance events that cause injuries and mortalities and force animals to expend energy fleeing. Walrus that are repeatedly disturbed will abandon an area and, as a result, may move to less desirable habitats. We anticipate minor impacts to walrus from OCS associated aircraft activities. The level of effect to other non-ESA-protected marine mammals from any additional aircraft activities associated with the Proposed Action is anticipated to be negligible.

4.4.2.8.3.1.1.3. Effects from Seismic-Survey Noise. Vessel-based seismic activities on existing leases and leases resulting from Lease Sales 209 and 217 are not likely to increase OCS-related vessel activity above existing levels in the Beaufort Sea. While there may be more leases, approximately the same level of OCS-related survey effort is anticipated to occur.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects from seismic-survey noise to ice seals are the same as described in Section 4.4.1.8.3.1.1.3. A negligible level of effects from seismic survey noise is expected for ice seals under Alternative 2.

Pacific Walrus. Some temporary displacement from foraging or resting habitat may occur, but few walrus are expected to be in open-water areas of the Beaufort Sea during summer season when most seismic activities take place. Mitigation measures currently in place for seismic activities are expected to reduce the potential for impacts to walrus even further. Seismic operations in open water typically are required to have marine mammal observers on board. Operations begin only after the observers have determined that no marine mammals are present within range of an injurious level of sound. Operations begin with a ramp-up procedure that requires the gradual increase in the level of noise. If a marine mammal appears within a specified range during operations, the observer notifies the operators who shut down operations until the animals are clear of the zone. For Pacific walrus, the safety radius has been identified as 180 dB. For more specific information on mitigation measures, see Section 4.4.2.8.2. Seismic activities taking place in the Beaufort Sea are expected to have negligible impacts to walrus.

Beluga Whale. Vessel-based OCS seismic activities on leases resulting from Lease Sales 209 and 217 are not likely to increase OCS seismic-survey activity above existing levels in the Beaufort Sea. While there may be more leases, approximately the same level of OCS-related survey effort is anticipated to occur, and the Proposed Action would have no effect on belugas. If there were any increases, we assume the increase would be small and that mitigation measures imposed by MMS and conditions of an IHA issued by the NMFS would reduce any effects of the activities to a negligible level, as required by MMPA.

Gray Whale. The low numbers of gray whales that occur in the nearshore shelf waters of the Beaufort Sea could be affected by 2D/3D/4D and high-resolution surveys, as described for endangered baleen whales in Section 4.4.2.6.1.3.1. Displacement from feeding areas and avoidance of active seismic activity noise are typical responses of gray whales to seismic noise. Seismic activities would be subject to mitigation measures, terms and conditions of IHAs issued by NMFS under the MMPA; therefore, effects would remain at negligible levels.

Effects of Noise from 2D/3D/4D Seismic-Surveys. It is expected that prospective OCS leaseholders and others would conduct 2D, 3D, or 4D seismic surveys to evaluate existing lease blocks and potential lease blocks for oil and gas resources in Beaufort Sea Planning Area prior to and after Lease Sales 209 and 217. These surveys would occur during the open-water period, and noise introduced to the marine environment by such surveys potentially is anticipated to injure, disturb, or modify behavior of gray whales during important seasonal movements, feeding-concentration periods, and locations. The

2D/3D/4D seismic activities would be subject to mitigation measures, terms, and conditions of IHAs issued by NMFS and MMS mitigation measures to avoid or minimize effects such that anticipated adverse effects on gray whales are negligible to the population.

Effects of Noise from High-Resolution Seismic Surveys. It is expected that leaseholders and others would conduct high-resolution seismic surveys to evaluate and support oil and gas exploration drilling, delineation, and production on leases obtained from Lease Sales 209 and 217. If potential commercial deposits are indicated, localized high-resolution seismic surveys would be expected to increase, as leaseholders evaluate and plan specific exploration, delineation, development, and production activities. High-resolution surveys would be expected to decline in localized areas, as production and transport facilities are completed. High-resolution seismic activities would be subject to mitigation measures and terms and conditions of IHAs issued by NMFS, and MMS mitigation measures, to avoid or minimize effects such that anticipated adverse effects to gray whales are negligible.

4.4.2.8.3.1.2. Anticipated Level of Effect from Exploration and Production Drilling Noise.

Additional lease sales in the Beaufort Sea could result in more leases that could be explored. Exploration could identify additional fields of economically recoverable oil or gas. Exploration drilling likely would involve drillships; however, gravel islands, bottom-founded platforms, and other drilling technologies could be feasible for exploration and if development and production are pursued. Up to two drillships are anticipated to be operating simultaneously in the Beaufort Sea. These may drill at more than a single location in a given year. While production of new fields in the Beaufort Sea OCS is not anticipated, exploration drilling can occur as lease holders delineate fields or otherwise determine the economic potential for producing that field. There are no drillships currently active in the Beaufort OCS; however, drilling has occurred there in the past. Details on source- and received-sound levels for these drilling activities can be found in the recent MMS Biological Evaluation for the Arctic (USDO, MMS, 2006c) and Richardson et al. (1995a), and are considered in the analyses below.

Ringed, Spotted, Ribbon, and Bearded Seals. The noise associated with drilling may displace some ice seals from the immediate area. The effects of this displacement, if any occurs, are likely to be negligible in the Beaufort Sea.

Pacific Walrus. The noise associated with drilling may displace walrus from the immediate area. The effects of this displacement, if any occurs, are likely to be negligible in the Beaufort Sea.

Beluga Whale. The noise associated with drilling may displace some beluga whales from the immediate area. This displacement is anticipated to have a negligible level of effect on beluga whales in the Beaufort Sea.

Gray Whale. Drilling on OCS leases is anticipated as leaseholders explore and develop potential productive oil and gas finds. Gray whale response to stationary sound sources indicates avoidance and behavioral modification that includes altering travel path or deflecting slightly around drill operations (Malme et al., 1984). Gray whales are not present during winter when ice cover predominates. During summer and fall, gray whales could be exposed to drilling noise, and an avoidance response would be anticipated. Drillship operations, drill location, platform placement and construction, and support activities are subject to MMS mitigation measures that avoid or minimize adverse effects to gray whales. Effects from drillship operations can cause slight deflection of some whales from original travel route; however, the deflection is transitory after passage of a drillship or platform after an avoidance deflection occurs. Synergistic adverse effects as a result of platform placement and construction, drilling, and other concurrent activities are avoided or minimized by application of mitigation measures that avoid or minimize the footprint of multiple activities relative one another and to gray whale biological activities

and movement. Localized prey concentrations, in part, may be locally avoided by some whales when in close proximity to active drilling operations; however, gray whales, like bowhead whales, may be more likely to tolerate sound when motivated to feed in such areas. Similar tolerance responses of gray whales under similar circumstances are uncertain. It is unknown whether tolerating higher level sound exposure in high-concentration feeding areas results in TTS or PTS in gray whales. Some individuals could experience TTS or PTS, but it is uncertain at this time. A negligible level of effect on the population is anticipated.

4.4.2.8.3.1.3. Anticipated Level of Effect from Vessel and Aircraft Disturbance. Aircraft- and vessel-related postlease OCS activities on new leases resulting from Lease Sales 209 and 217 could result in a small increase in OCS exploration aircraft and vessel activity above existing levels in the Beaufort Sea. While there may be more leases, the new leases would not necessarily increase the level of OCS-related aircraft and vessel activity in the Beaufort Sea. We assume that the increase that could be attributed to the new leases is small. Vessel operations associated with OCS activities are anticipated to have a negligible or minor level of effect on the non-ESA marine mammal species previously discussed in the Beaufort Sea, with the exception of icebreaker, which could have a minor level of effect on ringed seals.

4.4.2.8.3.1.3.1. Effects from Vessel Disturbance. Mitigation measures imposed by MMS and FWS/NMFS on potential future exploration and development activities would help avoid or minimize adverse effects to non-ESA listed marine mammals in the Beaufort Sea from OCS-related vessel traffic. For example, mitigation measures required by LOAs/IHAs typically have included onboard marine mammal observers and avoiding marine mammals by changing vessel course to avoid a collision, reducing vessel speed, or by avoiding some areas altogether. Offshore exploration-related vessel activities during the open-water season in the Beaufort Sea are likely to have a negligible level of effect on the non-ESA marine mammal species previously discussed in the Beaufort Sea. Icebreaker traffic can be expected to result in a minor level of effects on ringed seals.

4.4.2.8.3.1.3.2. Effects from Aircraft Disturbance. Mitigation measures imposed by MMS and FWS/NMFS on potential future exploration and development activities would help to avoid or minimize adverse effects to non-ESA listed marine mammals in the Beaufort Sea from OCS-related air traffic. For example, mitigation measures required by LOAs typically have stated that air traffic associated with offshore oil and gas leases are required to avoid walrus haulout areas by a lateral distance of >0.5 statute miles and a minimum altitude of 1,500 ft, unless weather conditions make this unsafe. Avoidance of walrus by these minimum distances would reduce the risk of major disturbance events, such as stampedes. In addition to causing injuries and mortalities, stampedes have a huge energetic cost. Walrus that are repeatedly disturbed will abandon an area and, as a result, may move to less desirable habitats. Aircraft operations associated with OCS activities are anticipated to have a negligible or minor level of effect on the non-ESA marine mammal species previously discussed in the Beaufort Sea.

4.4.2.8.3.1.4. Anticipated Level of Effect from Subsistence. Gray whales have not been harvested in the Beaufort Sea by Alaskan Natives for more than a decade and are not expected to be so in the future. The MMS-authorized activities resulting from additional lease sales are not anticipated to affect subsistence use of seals, walrus stocks, or beluga whales in the Beaufort Sea. Section 4.4.2.12 contains a detailed analysis of subsistence activity under Alternative 2.

4.4.2.8.3.1.5. Anticipated Level of Effect from Habitat Loss. Sources of habitat loss include community and industrial development. The anticipated effects from the various types of habitat loss are discussed below.

4.4.2.8.3.1.5.1. Community Development. Some marine mammal habitat may be altered by activities associated with community development; however, the Proposed Action is not anticipated to have a direct effect on community development.

4.4.2.8.3.1.5.2. Industrial Development. Some marine mammal habitat may be altered by activities associated with oil and gas exploration and development. These include the discharge of drilling wastes and construction of industrial facilities.

Drilling Wastes. Exploratory drilling may cause some displacement of the benthic invertebrates, which are a primary food source for some ice seals, whales, and walrus. The amount of habitat that could be affected is small compared to the amount of habitat available and the number of marine mammals using it. A negligible level of effect is anticipated.

Industrial Facilities. Production facilities and associated activities currently are not considered to be reasonably foreseeable from these lease sales. Specific effects from a production project would be analyzed on a project-by-project basis to determine the anticipated effects on ice seal, walrus, and whale populations if a discovery is made and proposed for development in the more distant future.

Ringed, Spotted, Ribbon, and Bearded Seals. Due to their dispersed distribution, production activities are not likely to have more than a negligible or minor effect on ice seals. A negligible level of effects from industrial development is expected to ice seals under Alternative 2.

Pacific Walrus. Walrus do not typically form large terrestrial haulouts in the Beaufort Sea, although some small haulouts have formed near Barrow in recent years. The primary impacts to walrus from production-related activities include habitat losses due to construction of development/production facilities, pipelines, and the associated infrastructure. Habitat loss in the Beaufort Sea is expected to have negligible effects to walrus given their current distribution.

As sea ice continues to retreat, walrus movement patterns and terrestrial haulout use may change. Walrus may shift their movements in response to declining sea ice and other habitat changes. Continued monitoring of movements of the walrus population would ensure that MMS and FWS had sufficient knowledge to respond to changing migration patterns and habitat use, and that walrus would not be adversely impacted by ongoing oil and gas activities in the Beaufort Sea. Unless walrus distribution changes to increase use of the Beaufort Sea, production activities in the Beaufort Sea are not likely to have more than a negligible effect on walrus.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. Effects from habitat loss in the Beaufort Sea would depend on the location and extent of alteration. Production facilities and activities on- and offshore are not considered reasonably foreseeable, and we do not have sufficient information on potential locations and types of facilities to be able to analyze specific impacts. These impacts would be analyzed when a development and production plan is submitted to MMS. Some localized whale offshore habitat may be altered by activities associated with exploration. Impacts to whales from habitat loss due to exploration are anticipated to be negligible.

4.4.2.8.3.1.6. Anticipated Level of Effect from Environmental Contaminants. Discharges containing contaminants could be released onto the seafloor and marine environment during the drilling of exploration wells. Drilling wastes (cuttings) may contain naturally occurring heavy metals, such as cadmium, which were formerly sequestered in the seafloor and are then released onto the seafloor surface. These naturally occurring contaminants may be picked up by benthic invertebrates and move up the food

chain, becoming more concentrated in higher trophic levels. Local sites where releases may occur would depend on the number and location of exploration wells. Mitigation measures require that most discharges (cuttings and drilling muds) from production wells be reinjected into authorized disposal wells.

Ringed, Spotted, Ribbon, and Bearded Seals. Ice seals accumulate heavy metals, organochlorine, and other toxins over the course of their lives, normally through consumption of food items. The literature suggests environmental contamination levels in northern ice seals are consistent with trends seen elsewhere with each respective species. Long-term monitoring could better assess temporal trends for the accumulation and effects of environmental contaminants in ice seals. The anticipated level of effects from environmental contaminants is the same as was described in Section 4.4.1.8.3.2.7.

Pacific Walrus. There is not enough information on current contaminant levels in walrus to be able to assess trends. Past studies have shown low levels of organochlorine, and heavy metals in walrus. Walrus are susceptible to bioaccumulation through ingestion of benthic prey items. Ongoing assessments of contaminant levels, both in walrus and in their prey items, on a more regular basis would help to determine whether changes were taking place.

Beluga Whale. Belugas are threatened everywhere by pollution of their environment. Researchers recently demonstrated that mercury levels in beluga muscle tissue reflect biomagnification processes rather than bioaccumulation over time. Researchers found that beluga length defined habitat specificity, and the consequent difference in habitat use resulted in different diets and dietary mercury sources (Loseto, Stern, and Ferguson, 2008). Contaminants that enter the sea tend to become concentrated as they move up the food chain, and could pose a health risk to belugas. Elsewhere, belugas found dead have contained high levels of organochlorines, lead, and mercury. The population-level effects from the presence of such levels of contamination are unknown.

Concentrations of PCBs, DDT, and other pesticides have declined in the Arctic since the 1980s; however, cetaceans in the Arctic may still be at risk for adverse health effects (Wilson et al, 2005). Temporal trends in the levels of organic pollutants are not obvious; studies comparing levels of POPs in the 1980s with levels in the 1990s show no apparent change (CDFO, 2000). Due to prey selection, toothed whales, such as belugas, accumulate contaminants to a higher degree than baleen whales, such as gray whales. We are unable to determine how environmental contaminants might affect belugas in the Chukchi Sea lease-sale area. Due to prey selection, beluga whales accumulate contaminants to a higher degree than baleen whales.

Gray Whale. There could be alterations in gray whale habitat as a result of exploration well discharges, including localized smothering of seafloor habitats. We refer readers to the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a) for a detailed discussion of drilling muds and other discharges associated with exploration drilling, with probable scenarios regarding the disposal of these substances and for discussion of the potential effects to water quality from their discharge. Any potential adverse effects to baleen whales from discharges are related directly to whether or not any potentially harmful substances are released, if they are released to the marine environment, what their fate in that environment likely is (e.g., different hypothetical fates could include rapid dilution or biomagnification through the food chain) and, thus, whether they are bioavailable to the species of interest.

4.4.2.8.3.1.7. Anticipated Level of Effect from Petroleum Spills. The MMS assessments of oil-spill impacts are based on a combination of factors, including the chance of one or more large spills occurring, spill size, spill duration, and weather conditions. Spills could occur on land or in the marine environment. Spills into the marine environment have the potential to travel with water currents or the ice

and to spread rapidly, depending on season, wind, and weather conditions. Spills in the marine environment have the greatest potential to affect marine mammals in the Beaufort Sea. The effects of exposure to oil on marine mammals are reviewed in Section 4.4.1.8.1.6. This analysis assumes that marine mammals contacted by oil may not survive, and that they could be impacted by ingesting prey that had either been directly oiled or had absorbed oil through their own feeding processes. Many benthic invertebrates are filter feeders, which tend to concentrate hydrocarbons through bioaccumulation. Marine mammals may continue to be affected by contaminants ingested long after oil has ceased to be apparent on the surface of the water. Pinnipeds or whales could come into contact with oil in the open lead system, in pack ice, or along the coastline. Pinnipeds or whales that become oiled could suffer effects to vision, inhale toxic fumes which could result in respiratory or digestive illnesses, or suffer skin lesions, among other potential effects.

The same oil spill mitigation measures described for existing leases in the Beaufort Sea (USDOJ, MMS, 2006b:Section IV.C.3) would be implemented for the proposed lease sales. For the OSRA model, the chance that a large oil spill would contact a specific environmental resource area assumes no clean up or mitigation is in place. A large spill from a well blowout is described as a very unlikely event, and we assume that no large oil spills will occur during exploration activities (Appendix A, Section 1.1.4).

The MMS OSRA model quantifies the percent chance that a large spill ($\geq 1,000$ bbl) would contact important environmental resource areas. We analyze the potential effects from large oil spills to determine which areas would have the highest chance of contact for each resource. In the following sections, we evaluate the vulnerability of marine mammals to oil spills, describe the potential effects of disturbance from postspill cleanup activities, the potential effects of prey reduction or contamination, and the anticipated effects on marine mammal populations.

4.4.2.8.3.1.7.1. Oil-Spill Analysis. To put the chance of a large spill affecting marine mammals in perspective, one must consider several variables. First, for a large oil spill to occur, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find ranged from 17-50%, indicating that production is unlikely (USDOJ, MMS 2003a). Second, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach environmental resource areas important to marine mammals, if and when they are present or, in the case of a winter spill, when migrating marine mammals return. Finally, the number, sex/age, of the marine mammal population and the duration and type of exposure to marine mammals would influence the anticipated effects.

The potential for spills to contact marine mammals in the Beaufort Sea was described in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a). Due to small adjustments in the environmental resource area polygons (size/shape), changes in lease areas, and other model refinements, we have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are much the same as those for the previous multiple lease sales in the Beaufort Sea.

The following oil-spill analysis presents conditional and combined probabilities expressed as percent chance. Conditional probabilities assume that a large spill has occurred, and model the chance of that spill contacting a particular environmental resource area. For a full description of the oil-spill model used, see Appendix A. Combined probabilities model the chance of one or more large spills occurring and contacting a particular environmental resource area. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting environmental resource areas and land segments or grouped land segments (GLSs). Environmental resource area locations are found in Appendix A in Maps A.1-2a through 2e. and land segments in Maps A.1-3a through 3d. The OSRA model assumes that a spill starts at a specific launch area or pipeline segment. The launch areas and pipeline segments for the Beaufort Sea area are found in

Appendix A, Map A.1-4. An environmental resource area can represent an area important to one or more species or species groups during a discrete amount of time.

Ringed, Spotted, Ribbon, and Bearded Seals. Northern ice seals are known to use both near- and offshore habitat throughout the year. If a large oil spill were to occur in the Beaufort Sea analysis area, ice seal habitat would be directly impacted. We anticipate a large oil spill would result in a moderate level of effect on ice seals in the Beaufort Sea.

Pacific Walrus. The potential for large spills to contact walrus habitat in the Beaufort Sea was analyzed in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS, 2003a). This analysis was updated in the Sale 202 EA (USDOJ, MMS 2006b). We have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are similar to past analyses. This section analyzes potential oil-spill impacts to walrus. Oilspill impacts to the benthic environment could impact walrus by limiting prey available to them, or by causing mortality from secondary contamination. These impacts are analyzed in Section 4.4.2.3. In the unlikely event of a large spill occurring and contacting an area where walrus were present in the Beaufort Sea, some walrus might experience some physical effects from contact with oil or from ingesting oiled prey items. This is expected to have no more than negligible effects to the walrus population.

Beluga Whale and Gray Whale. Given the stated low chance of successful oil field development, the low likelihood that a large spill would occur, and the low percent chance that a large spill would reach resource areas important to and occupied by beluga and gray whales, including those areas with migrating and feeding beluga and gray whales concentrated in the open-water period, a spill causing adverse effects of a magnitude to have long-term population-level effects appears to be a low-likelihood event. The MMS would require an OSRP to further reduce the opportunity for spilled oil to reach environmental resource areas important to whales and remove oil from the marine environment.

Considering the low probability of a large spill occurring, coupled with a variety of other factors that would need to be satisfied to result in population-level effects, the MMS anticipates that gray whales would experience a minor level effect as a result of oil spills associated with the Proposed Action, Mortality of some individuals could occur but are not anticipated.

Conditional Probabilities. This section discusses the chance that a large oil spill from portions of the Beaufort Sea lease sale area could contact specific environmental resource areas that are important to nonthreatened and nonendangered marine mammals. Conditional probabilities assume that a large spill has occurred and that no cleanup takes place.

The estimated chance of one or more large platform or pipeline spills occurring as a result of production from Lease Sales 209 or 217 is 26% over the 20-year production life. This estimated chance of one or more large spills occurring remains constant regardless of the selection of any combination of deferrals. The development scenario assumes that three fields are developed, and that production occurs over a period of 20 years (Table A.1-26). For development and production phases, the fate and behavior of a 1,500-bbl oil spill from a platform and a 4,600-bbl oil spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A).

A 1,500-bbl platform spill occurring during the summer season (between July and September) could cover approximately 9 km² after 3 days and 181 km² of discontinuous area after 30 days, and could oil an estimated 29 km of coastline (Table A.1-6). A melt-out spill of the same size from a platform could cover 7 km² after 3 days and 143 km² of discontinuous area after 30 days, and could oil an estimated 32 km of coastline (Table A.1-6). These examples highlight the critical importance of an immediate response from

onsite oil-spill-response personnel and equipment, although winter cleanup might have limited effectiveness, particularly in broken-ice conditions.

Approximately 40% of a 4,600-bbl pipeline spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer, potentially causing major impacts to walrus. Approximately 69% of a 4,600-bbl pipeline spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km² (Table A.1-7).

The following large oil-spill analysis presents conditional and combined probabilities expressed as a percent chance. Conditional probabilities assume that a large spill has occurred, and model the chance of that spill contacting a particular environmental resource area (see Appendix A). Combined probabilities model the chance of one or more large spills occurring and contacting a particular environmental resource area. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the environmental resource areas and land segments or Grouped Land Segments. The OSRA model assumes that a spill starts at a specific launch area or pipeline segment. There are 25 launch areas and 17 pipeline segments considered in the model, and they are shown in Map A.1-4. An environmental resource area can represent an area important to one or more species or species groups during a discrete amount of time. Unless otherwise noted, the conditional probabilities discussed are during summer or winter within 30 and 360 days for environmental resource areas and land segments and are found in Tables A.2-65, 66, 71, 72, 113, 114, 119, 120, 125, 126, 131, and 132. The data are summarized for LAs 1-25 and PLs 1-17, unless otherwise specified. The winter and summer discussed below are the time periods when a large spill could start. A summer spill is defined as a spill that occurred between July 1 and September 31; a winter spill is defined as a spill that occurred between October 1 and June 30. Conditional probabilities assume that a large spill has occurred and do not assume that any oil-spill response (cleanup activities) occurs- Oil spill response is analyzed separately.

Ringed, Spotted, Ribbon, and Bearded Seals. Sea-ice habitats can be categorized as shorefast; persistent flaw zones; or leads, polynyas, divergence zones, and the ice edge or front. Ringed seals occur in all of these ice zones. Bearded seals are found in all but shorefast ice. Ribbon and spotted seals are found along the ice edge in winter only (roughly February through April). In summer, ribbon seals remain in open waters, while spotted seals use a variety of shoreline and sandbar haulouts (Burns, Shapiro, and Fay, 1980). It is difficult to identify particular areas for large oil-spill analysis, because the primary habitat, sea ice, is a constantly changing and moving environment. Areas that remain consistent among years and that were identified for this analysis include the spring lead systems in the Beaufort Sea (ERAs 24-28) and Chukchi Sea (ERA19), and the polynya areas near Point Lay (ERA39) and Wainwright (ERA40) in the Chukchi Sea. Spotted seal haulouts are located at Kasegaluk Lagoon (ERA1) and Cape Espenberg (LS48) in the Chukchi Sea, and Smith Bay (ERA65) and Harrison Bay (ERAs 68-69) in the Beaufort Sea. The following describes the conditional probabilities estimated by the OSRA model of a large oil spill in the Beaufort Sea contacting environmental resource areas important to ice seals as discussed above during summer and winter.

Summer Spill. The OSRA model estimates that the percent chance of a large oil spill contacting the Beaufort Sea spring lead system within 30 days is <0.5% for all launch areas and ≤1% for all pipeline segments. Within 360 days, the percent chance of contacting the Beaufort Sea spring lead system varies from <0.5-6%. The OSRA model estimates the percent chance of a large oil spill contacting the Chukchi Sea spring lead system within 30 days as <0.5% and ≤1% within 360 days. The percent chance of a large oil spill contacting the Point Lay polynya area, Cape Espenberg, and Kasegaluk Lagoon is <0.5% within 30 and 360 days. The percent chance of a large oil spill contacting the Wainwright polynya area is ≤1%

within 30 days and $\leq 2\%$ within 360 days. The percent chance of a large oil spill contacting Smith Bay is $<0.5-21\%$ within 30 days for all launch areas and $<0.5-22\%$ within 360 days. The percent chance of a large oil spill contacting Harrison Bay is $<0.5-44\%$ within 30 day and $<0.5-46\%$ within 360 days.

Winter Spill. The OSRA model estimates the percent chance of a large oil spill contacting the Beaufort Sea spring lead system within 30 days is $<0.5-27\%$. Within 360 days, the percent chance is $<0.5-32\%$. The percent chance of a large oil spill contacting the Chukchi Sea spring lead system within 30 days is $<0.5-9\%$ for all launch areas and $<0.5-7\%$ for all pipeline segments. Within 360 days, the percent chance of contacting the Chukchi Sea spring lead system is $<0.5-19\%$ for all launch areas and $<0.5-5\%$ for all pipeline segments. The percent chance of a large oil spill contacting the Point Lay polynya area, Kasegaluk Lagoon, and Cape Espenberg is $<0.5\%$ within 30 and 360 days. The percent chance of a large oil spill contacting the Wainwright polynya area is $\leq 1\%$ within 30 days and $\leq 2\%$ within 360 days. The percent chance of a large oil spill contacting Smith Bay is $\leq 3\%$ within 30 days and $<0.5-14\%$ within 360 days. The percent chance of a large oil spill contacting Harrison Bay is $<0.5-12\%$ within 30 days and $<0.5-39\%$ within 360 days.

Pacific Walrus. A 1,500- or a 4,600-bbl spill could contact environmental resource areas where walrus may be present (Table A.1-16). The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting identified walrus habitats.

A large oil spill that occurred in summer, or winter and persisted into summer, could impact walrus coming ashore due to sea-ice retreat, or in the spring lead system and along the ice edge. Although walrus are largely extralimital in the Beaufort Sea, this may be changing as pack ice diminishes. In summer 2007, walrus were found hauling out near Barrow and on some offshore manmade islands (Garlich-Miller, pers. commun.). It is difficult to predict where walrus might be found, because their distribution is heavily dependent on sea ice. For this analysis, we focused on the spring lead system represented by ERAs 24, 25, 26, 27, and 28 and the shoreline near Barrow, which includes Barrow, Browerville, and Elson Lagoon, represented by LS 85.

Summer Spill. The OSRA model estimates the percent chance of a large oil spill contacting the spring lead system within 30 days is $<0.5\%$ for all launch areas and $\leq 1\%$ for all pipeline segments. Within 360 days, the percent chance is $<0.5-6\%$. The OSRA model estimates the percent chance of a large oil spill contacting the Barrow area within 30 days is $<0.5-8\%$ for all launch areas and $<0.5-4\%$ for all pipeline segments. Within 360 days, the percent chance is $<0.5-13\%$ for launch areas and $<0.5-8\%$ for pipeline segments.

Winter Spill. The OSRA model estimates the percent chance of a large oil spill contacting the spring lead system within 30 days is $<0.5-27\%$. Within 360 days, the percent chance is $<0.5-32\%$. The OSRA model estimates the percent chance of contacting the Barrow area within 30 days is $\leq 2\%$ for all launch areas and $\leq 1\%$ for all pipeline segments. Within 360 days, the percent chance of contacting the Barrow area is $<0.5-6\%$.

Beluga Whale and Gray Whale. This section discusses the chance that a large oil spill from the Beaufort Sea lease sale area would contact specific environmental resource areas that are important to beluga or gray whales. The narwhal occurs in the U.S. waters of the Beaufort Sea occasionally, but specific areas have not been identified as important habitat for the narwhal, and it is not discussed further in this section.

The OSRA model estimates conditional probabilities (expressed as a percent chance) of a large spill contacting identified beluga and gray whale habitats. A 1,500- or a 4,600-bbl spill could contact

environmental resource areas where beluga or gray whales may be present (Table A.1-16). A large oil spill that occurred in summer, or occurred in winter and persisted into summer, could impact whales in the spring lead system and along the ice edge, or in nearshore waters. Both beluga and gray whales are present in the Beaufort Sea in the summer ice-free months. Gray whales have been seen more frequently and in higher numbers in recent years, possibly in response to changes in food availability.

In winter, belugas are associated with the pack ice in offshore waters and are thought to move southward into the Bering Sea. In spring and summer, belugas move into warmer bays and coastal areas to molt and to give birth (Angliss and Outlaw, 2005). For this analysis, we focused on estuaries and bays where belugas regularly occur in spring and summer. The following environmental resource areas were identified for belugas: Kasegaluk Bay (ERA1), Kotzebue Sound (ERA13), King and Shingle Points in the Canadian Beaufort (ERA60) and the Mackenzie River Delta in the Canadian Beaufort (ERA62). We also included polynya areas, and the spring lead systems and the nearshore waters in the Beaufort and Chukchi near Barrow. The Beaufort Sea spring lead system is represented by ERAs 24, 25, 26, 27 and 28. The Chukchi Sea spring lead system is represented by ERA19. The Barrow area is represented by ERA41 on the Chukchi Sea side and ERA42 on the Beaufort Sea side. The Point Hope area is ERA38. The Point Lay polynya area is ERA39. The Wainwright area is ERA40. The Kaktovik area is ERA44.

Most of the Eastern North Pacific gray whales spend the summer feeding in the Bering and Chukchi Seas. In late fall, they migrate southward down the coast to Baja California. The following environmental resource areas were identified for gray whales: sections of nearshore waters along the Russian Chukotka Peninsula, these included areas near Kolyuchin Bay, and between Kolyuchin Bay and the Bering Strait (ERAs 3, 4, and 16), the offshore polynya area between Barrow and Wainwright (ERA35), the Herald Shoal polynya (ERA46), and the Hanna Shoal area (ERA48).

Summer Spill. The OSRA model estimates the percent chance of a large oil spill contacting the Beaufort Sea spring lead system within 30 days is <0.5 for all launch areas and $\leq 1\%$ for all pipeline segments. Within 360 days, the percent chance of contacting the spring lead system is <0.5-6% for either launch areas or pipeline segments. The chance of contacting the Barrow area within 30 days is <0.5-8% for all launch areas and <0.5-4% for all pipeline segments. Within 360 days, the percent chance of contacting the Barrow area is <0.5-69% for launch areas and <0.5-61% for pipeline segments. The percent chance of contacting the Chukchi sea spring lead system is <0.5% within 30 days and $\leq 1\%$ within 360 days. The percent chance of contacting Kasegaluk Lagoon, Kotzebue Sound, the Point Hope area, or the Point Lay area is <0.5% within 30 and 360 days. The percent chance of contacting the Wainwright polynya area is $\leq 1\%$ for within 30 days and rises to $\leq 2\%$ for launch areas within 360 days. The percent chance of contacting the Kaktovik area within 30 days is <0.5-26% for launch areas and <0.5-39% for pipeline segments, and <0.5-31% for launch areas and from <0.5-43% for pipeline segments within 360 days. The percent chance of contacting King and Shingle Points or the Mackenzie River Delta in the Canadian Beaufort Sea is <0.5% within 30 days and <0.5-4% within 360 days. The percent chance of contacting the Mackenzie River Delta within 360 days is $\leq 2\%$.

Along the Russian coastline (ERAs 3, 4, and 16), the percent chance of a large spill contacting is <0.5% within 3-360 days. The percent chance of contacting the offshore area between Barrow and Wainwright varies from <0.5-21% for launch areas and <0.5-13% for pipeline segments within 30 days. The percent chance of contacting the offshore area between Barrow and Wainwright is <0.5-24% for launch areas and <0.5-15% for pipeline segments within 360 days. The percent chance of contacting the Herald Shoal area is <0.5% within 30 and 360 days. The percent chance of contacting the Hanna Shoal area varies from $\leq 1\%$ within 30 days and from $\leq 2\%$ within 360 days.

Winter Spill. The OSRA model estimates the percent chance of a large oil spill contacting the Beaufort Sea spring lead system within 30 days is <0.5-27%. Within 360 days, the percent chance of contacting the Beaufort Sea spring lead system is <0.5-32%. The percent chance of contacting the Chukchi Sea spring lead system within 30 days is <0.5-9% for all launch areas and <0.5-7% for all pipeline segments. Within 360 days, the percent chance of contacting the Chukchi Sea spring lead system is <0.5-19% for all launch areas and from <0.5-12% for all pipeline segments. The percent chance of a large oil spill contacting the Barrow area within 30 days is $\leq 2\%$ for all launch areas and $\leq 1\%$ for all pipeline segments. Within 360 days, the chance of contacting the Barrow area is <0.5-6%. For ERA48, the percent chance of contacting is <0.5-7% for all launch areas and <0.5-5% for all pipeline segments within 360 days. For all other environmental resource areas considered in the summer analysis above, the percent chance of contact from a winter spill is much lower than from a summer spill.

Combined Probabilities. Combined probabilities differ from conditional probabilities in that there is no assumption that a large spill occurs. Instead, combined probabilities reflect the chance of one or more large spills occurring over the 20-year production life of the Proposed Action, and of any portion of that spill contacting any portion of a particular environmental resource area. Combined probabilities do not factor in any cleanup efforts. For more background, see Appendix A, Section 4.3. The combined probabilities are given in Tables A.2-157 and A.2-158.

Ringed, Spotted, Ribbon, and Bearded Seals. Only environmental resource areas that have a percent chance of occurrence and contact higher than <0.5% are discussed below. All other environmental resource areas discussed in the conditional probabilities section above are not discussed further in this section. The combined probabilities of one or more large spills ($\geq 1,000$ bbl) occurring and contacting the Beaufort Sea spring lead system is <0.5% within 3 days, $\leq 1\%$ within 3-10 days, $\leq 2\%$ within 30-60 days, and $\leq 3\%$ within 180 -360 days. The combined probabilities of one or more large spills occurring and contacting the Chukchi Sea spring lead system and Smith Bay is <0.5% within 3-60 days until within 180 days, when the percent chance rises to 1% and remains at 1% 360 days after the spill. The combined probabilities of one or more large spills occurring and contacting Harrison Bay is $\leq 1\%$ within 3 days until 180 days after a spill, when the chance rises to 2% and remains at 2% 360 days after the spill.

Pacific Walrus. The combined probabilities of one or more large spills occurring and contacting the Beaufort Sea spring lead system is <0.5% within 3 days, $\leq 1\%$ within 3-10 days, $\leq 2\%$ within 30-60 days, and 1-3% 180 days through 360 days. The combined probabilities of one or more large spills occurring and contacting the Barrow area is <0.5% within 3 days until 180 days after a spill, when the percent chance rises to 1% and remains at 1% 360 days after the spill. Considering the low probability of a large spill occurring and the relatively low vulnerability of this species in the Beaufort Sea, the MMS anticipates that it is highly improbable that the Pacific walrus population would experience more than negligible impacts as a result of oil spills associated with the Proposed Action.

Beluga Whale and Gray Whale. Only environmental resource areas that have a percent chance of one or more large spills occurring and contacting higher than <0.5% are discussed below. All other environmental resource areas discussed in the conditional probabilities section above are not discussed further in this section.

For environmental resource areas that have been identified as important to beluga, the combined probabilities of one or more large spills occurring and contacting the Beaufort Sea spring lead system is <0.5% within 3 days, $\leq 1\%$ within 3-10 days, $\leq 2\%$ within 30-60 days, and $\leq 3\%$ 180 days through 360 days. The combined probabilities of one or more large spills occurring and contacting the Kaktovik area (ERA44) is $\leq 1\%$ within 3 days until 180 days after a spill, when the percent chance rises to 2% and

remains at 2% 360 days after the spill. The combined probabilities of one or more large spills occurring and contacting the Barrow area (ERA42) is $\leq 1\%$ within 3 days until 180 days after a spill, when the percent chance rises to 2% and remains at 2% 360 days after the spill.

For environmental resource areas that have been identified as important to gray whales, the combined probabilities of one or more large spills occurring and contacting the Chukchi Sea spring lead system (ERA19) is $< 0.5\%$ within 3 days until 180 days after a spill, when the percent chance rises to 1% and remains at 1% 360 days after the spill. The combined probabilities of one or more large spills occurring and contacting the offshore area between Barrow and Wainwright (ERA35) is $< 0.5\%$ within 3 days until 60 days after a spill, when the percent chance rises to 1% and remains at 1% 360 days after the spill

Considering the low probability of a large spill occurring, relatively low vulnerability of these species coupled with a variety of other factors that would need to be satisfied to result in population-level effects, the MMS anticipates that it is highly improbable that these whales would experience more than negligible, temporary, nonlethal effects to some individuals as a result of oil spills associated with the Proposed Action.

4.4.2.8.3.1.7.2. Chronic Low-Volume Spills. Small or low-volume spills are defined as spills $< 1,000$ bbl. Between 1989 and 2000, there have been 1,178 spills < 500 bbls on the Alaska North Slope. There have been six spills that were between 500 and 1,000 bbl. The total volume of all 95 spills combined was 306,277 gal or 7,292 bbl (Table A.1-29). An estimated 89 small crude oil spills < 500 bbl could occur during the 20-year oil production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average crude oil spill size is 126 gal (3 bbl) for spills < 500 bbl. The average refined oil spill size is 29 gallons (0.7 bbl) and an estimated 220 refined-oil spills could occur during the 20-year oil production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 low-volume oil spills could occur during each year over the 20-year production period.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects from low-volume spills to ice seals would depend on the location and timing of each spill, as well as the speed and success rate of cleanup efforts. Due to their patchy distribution and reliance on sea ice, it is difficult to predict where ice seals might encounter spilled oil. A low-volume oil spill is expected to have a negligible effect on ice seals in the Beaufort Sea.

Pacific Walrus. The effects from low-volume spills to walrus would depend on the location and timing of each spill, as well as the speed and success rate of cleanup efforts. Due to their patchy distribution and reliance on sea ice, it is difficult to predict where walrus might encounter spilled oil. Due to the low numbers of walrus in the Beaufort Sea, it is unlikely that walrus would experience more than negligible impacts from small spills.

Beluga Whale and Gray Whale. The effects from low-volume spills to whales would depend on the location and timing of each spill, as well as the speed and success rate of cleanup efforts. Small oil spills could be contacted by a few individuals that may experience temporary, nonlethal effects. A negligible level of effect on beluga and gray whales are anticipated from small spills.

4.4.2.8.3.1.7.3. Spill-Response Activities. Conditional and combined probabilities do not factor in the effectiveness of oil-spill-response activities to large or small spills. Oil-spill responses (cleanup efforts) vary from highly effective in calm, open water conditions to largely ineffective during unfavorable or broken-ice conditions. The MMS requires that each operator have an approved OSRP prior to the onset of production, and that equipment and trained personnel be available to respond to spills. The FWS also may review these plans as part of their LOA review process under the MMPA. In

general, oil-spill-response activities include containing the release and spread of oil, recovering oil as quickly as is safely possible, and keeping oil away from sensitive areas using boom or other resources.

Depending on the location of the spill, oil-spill response could take some time to begin. Oil-spill-response equipment is prepositioned in Barrow, and in Deadhorse, about 150 mi east of Barrow. Oil-spill-response personnel would be expected to work with the FWS and other State and Federal resource agencies on marine mammal management activities in the event of a spill.

To adequately protect marine mammals and their habitats from the threat of a large oil spill, or chronic small spills, mitigation measures currently in place must be adaptable to continued changes in marine mammal distribution and habitat use, for example, increasing use of the coastline by walrus in late summer and fall. Equipment and trained crews need to be able to respond rapidly to a spill as soon as it is discovered. The effectiveness of oil-spill-response measures will depend largely on the location of the spill, the distances involved, the season, and the weather along the Beaufort Sea coast.

In the unlikely event of a large spill contacting and extensively oiling marine mammal habitats, the presence of numerous oil-spill-response cleanup vessels, aircraft, and personnel is expected to cause displacement or avoidance response by marine mammals. Displacement or avoidance would serve to limit contact with spilled oil; however, displacement from prey concentrations and important feeding habitat could result. Prey resources and habitats would be relatively small when compared to the total prey base and habitat available in the Arctic. Any adverse effects associated with the response to an oil spill as described are considered preferable to not responding to the spill.

4.4.2.8.3.1.7.4. Prey Reduction or Contamination.

Ringed, Spotted, Ribbon, and Bearded Seals. The diets of northern ice seals are described in Section 3.3.6.1. The effects from oil spills to benthos are be found in Section 4.4.2.3. Section 4.4.2.4.3.1.3 provides details regarding the effects of oil spills on fish in the Beaufort Sea. While ice seals do bioaccumulate hydrocarbon byproducts over time and sequester many of these byproducts in their layer of fat, they also have the ability to excrete polar metabolites through their renal systems. Very little information exists in the form of trend analyses, or incremental analyses that show what the long-term effects of hydrocarbon exposure are, or what effects ensue from varying sublethal levels of hydrocarbon exposure. We expect a brief reduction or contamination of prey items for ice seals in the event of a large oil spill. We anticipate such an event would have a negligible level of effect on ice seals in the Beaufort Sea.

Pacific Walrus. Walrus feed predominantly on benthic invertebrates. For more information on the effects from petroleum spills to benthic invertebrates, see Section 4.4.2.3. Some walrus also may feed on small seals such as ringed seals, or pups of other seal species. Walrus may have increased contaminant loads over time if their prey species are contaminated, for example, with heavy metals, PCBs, or DDT. Studies indicate that all pinniped species have enzyme systems within their digestive systems that are capable of converting hydrocarbons into polar metabolites, which can be excreted in urine. There is little information on the potential effects of chronic ingestion of sublethal doses of hydrocarbon contaminants or what level of ingestion would prove lethal. Hydrocarbon contaminants could be transferred to nursing pups at higher concentrations, and pups may lack sufficient detoxifying enzymes. Ingesting contaminated food sources has been shown to cause liver and kidney damage, lesions and ulcers of the digestive tract in other mammals.

Beluga Whale. Potential effects from oil spills to beluga whales are discussed in Section 4.4.1.8.2. No large spills are anticipated to occur during exploration activities in the Alaska Beaufort Sea relative to

existing leases. This alternative is anticipated to result in negligible impacts to beluga whales, because petroleum spills are considered infrequent, illegal, or accidental events. Fresh oil spills with high concentrations of volatile aromatic hydrocarbons into marine waters associated with the Beaufort and Chukchi spring lead system concurrent with large numbers of beluga whales migrating through the lead system, present the greatest potential for effects to large numbers belugas and vulnerable newborn calves.

There is uncertainty about effects to cetaceans from of a large spill. In some years and in some locations, there are relatively large aggregations of feeding and molting beluga whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed; and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that beluga whales would suffer significant population-level adverse effects from a large spill originating in the Beaufort Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move toothed whales away from oiled areas) could cause short-term changes in local distribution and abundance. A moderate level of effect could occur.

Gray Whale. Spilled oil, if chemical dispersants or clay are used to break up surface oil and cause it to sink to the sea bottom, could adversely affect gray whales by contaminating benthic prey, particularly in primary feeding areas (Wursig, 1990; Moore and Clarke, 2002). Bottom muds also could be contaminated by oil deposits and be ingested by feeding gray whales. Any perturbation, such as an oil spill, which caused extensive mortality within a high-latitude amphipod population with low fecundity and a long generation time would result in a marked decrease in secondary production (Highsmith and Coyle, 1992). Effects from exposure of gray whales to spilled oil may, but are not anticipated to, result in lethal effects to a few individuals, and most individuals exposed to spilled oil likely would experience temporary, nonlethal effects. A minor level of effect is anticipated.

4.4.2.8.3.1.7.5. Vulnerability or Mortality of Marine Mammals to Petroleum Spills.

Ringed, Spotted, Ribbon, and Bearded Seals. Ringed seals and bearded seals may be found near the sea ice throughout the Proposed Action area. Spotted seals usually occur in the nearshore areas along the Beaufort Sea coast. Spotted seals are known to aggregate at the mouths of the Colville and Sagavanirktok rivers. Spotted seal numbers in the Beaufort Sea are believed to number only in the tens so the potential for exposure to an oil spill is very low. Because ribbon seals rarely have been observed in the Beaufort Sea, the potential for a ribbon seal to become exposed to spilled oil is much less than that of the spotted seal.

Ice seals typically rely on a thick layer of blubber for insulation rather than fur. Consequently, oiling of the pelt is not likely to result in any decreases in a seal's ability to thermoregulate in the Beaufort Sea. The two primary venues where oil seems to pose the greatest risk to ice seals are through ingestion of oiled foods, or through absorption of oil through openings in the seal's body. Smith and Geraci (1975) determined from field experiments that ringed seals exposed to crude oil showed evidence of kidney lesions, liver changes, and eye damage. In a related lab experiment, three ringed seals placed in a tank with an oiled surface layer died within 71 minutes of immersion. Because these studies were short duration, they reflect what likely would happen if an oil spill were to occur during the ice-free season.

Oil spills are most likely to affect northern ice seals if ingested with oiled food items, absorbed through body openings, inhaled, or possibly absorbed through the skin. However, no long-term studies relating to the issue of oiling of northern ice seals have been conducted. We anticipate an oil spill to have a moderate level of effect on ice-dependent phocid seals in the Beaufort Sea.

Pacific Walrus. Walrus inhabit the Beaufort Sea only in summer and may be found in small numbers as far East as Camden Bay. Walrus are vulnerable to spills that occur in summer or that occur at any time of the year, if there is oil remaining in the lead systems or in terrestrial haulout areas in summer. Little is known about the level of toxicity to walrus after the aromatic hydrocarbons have dissipated. After an oil spill occurs, the highly toxic aromatic hydrocarbons typically evaporate relatively quickly, sometimes within weeks if the oil is exposed to optimum environmental conditions. If the oil remains trapped in ice, frozen within sea ice for example, then the oil can retain aromatic hydrocarbons for months, until the oil eventually melts out and is exposed to wind and wave action. Walrus may inhale aromatic hydrocarbons when using breathing holes in the ice. Although oil toxicity decreases over time with weathering, this does not necessarily decrease the risk to walrus, because they may continue to ingest oil through their prey species long after a spill has occurred.

As sea ice breaks up in spring, walrus follow the receding ice edge and may come ashore in late summer and fall, where they remain until the sea ice re-forms in early winter. Large aggregations of walrus do not typically haul out along the Beaufort Sea coastline. It is unknown whether walrus would avoid oil in lead systems or on shore. It is unknown whether walrus would avoid their usual prey items due to oiling. Ingesting oiled prey could be a secondary source of injury from a spill.

Female walrus exhibit extremely strong bonds to their calves and will not leave them, even when being actively pursued by hunters. Therefore, it is unlikely that walrus would abandon their calves if threatened by oil pollution. Walrus groom themselves by scratching and rubbing themselves with their hind and fore flippers. They also will rub their faces and vibrissae with their fore flippers but are unlikely to ingest oil while grooming.

Walrus are long-lived mammals that mature slowly. Females generally produce a single calf every 2-3 years, beginning at roughly age 7. Walrus are demographically the most vulnerable of all pinniped species to population catastrophes such as oil spills (McLaren, as cited in Geraci and St. Aubin, 1990).

Although the biological potential for walrus to recover from moderate or major impacts to their population is low due to their low reproductive rate and long maternal investment in a single calf, we believe that due to the low numbers of walrus inhabiting the Beaufort Sea and the low combined probability of an oil spill impacting walrus habitat, spill effects likely would have a negligible impact on the walrus population in the Beaufort Sea.

Beluga Whale. Fresh oil spills with high concentrations of volatile aromatic hydrocarbons into marine waters associated with the Beaufort and Chukchi spring lead system concurrent with large numbers of beluga whales migrating through the lead system, present the greatest potential for effects to large numbers belugas and vulnerable newborn calves.

In some years and in some locations, there are aggregations of feeding and molting beluga whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed; and we cannot rule out population-level effects, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that beluga whales would be likely to suffer significant population-level adverse effects from a large spill originating in the Beaufort Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move toothed whales away from oiled areas) could cause short-term changes in local distribution and abundance. A moderate level of effect could occur.

Gray Whale. To put the chance of a large spill having population-level impacts in perspective, one must consider several variables. First, for an oil spill to occur, production would have to occur. The most likely scenario states the optimistic probability of a successful commercial find ranged from 17-50%, indicating that production is unlikely (USDOJ, MMS 2003a). Second, the location of the oil or gas find and subsequent development platform could influence the chance that a spill would occur as well as that it would reach environmental resource areas important to gray whales, if and when the whales are present or, in the case of a winter spill, when migrating whales return. Finally, the number, sex/age, of the whales and the duration and type of exposure to whales would have variable degrees of effects, from negligible, temporary, nonlethal effect to major mortality events having long-term population-level effect. Given the stated low chance of successful oil field development, the low likelihood that a large spill would occur, and the low percent chance that a large spill would reach resource areas important to gray whales, a spill causing adverse effects of a magnitude to have long-term population-level effects appears to be a low-likelihood event. No large spills are anticipated to occur during exploration activities in the Alaska Beaufort Sea relative to existing leases or leases resulting from Lease Sales 209 and 217. Spills associated with development/production projects and associated infrastructure for product transport may occur on existing leases in the Beaufort Sea OCS in addition to the Northstar and ongoing Liberty projects or adjacent State of Alaska oil and gas leases.

Gray whales would not be present in the Beaufort Sea except in low numbers during the open-water period. They would be vulnerable to inhaling toxic hydrocarbon within a few days of a fresh spill. In the unlikely event of a large oil spill, some individual gray whales may experience injury or mortality as a result of prolonged exposure to freshly spilled oil; however, opportunity for inhalation exposure with toxic hydrocarbons for a prolonged period would be unlikely. Most individuals exposed to spilled oil likely would experience temporary, nonlethal effects. Some individual whales could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, localized reduction in prey sources, consumption of petroleum and/or petroleum-contaminated food items, perhaps temporary displacement from feeding/resting areas, and temporary interruption of migration timing and route. Spilled oil, if chemical dispersants or clay are used to break up surface oil and cause it to sink to the sea bottom, could adversely affect gray whales by contaminating benthic prey, particularly in primary feeding areas (Wursig, 1990; Moore and Clarke, 2002). Bottom muds also could be contaminated by oil deposits and foul baleen or be inadvertently ingested by feeding gray whales. Any perturbation, such as an oil spill, which caused extensive mortality within gray whale prey such as a high-latitude amphipod population with low fecundity and a long generation time would result in a marked decrease in secondary production (Highsmith and Coyle, 1992).

Small, chronic petroleum spills rapidly dissipate volatile toxic compounds within hours to a few days through evaporation and residual components rapidly disperse in open waters. Individual gray whales potentially could be exposed to small fuel oil spills, and this exposure could have short-term, nonlethal effects to health. A negligible level of effect from seismic-survey-related small-spill is expected

Considering the low probability of a large spill occurring, a negligible level of effect to gray whales as result of oil spills is anticipated.

4.4.2.8.3.1.8. Anticipated Effects from Changes in the Physical Environment. Changes in the physical environment as a result of ongoing trends in climate change are having profound effects on many marine mammal species. The effects of these long-term trends on marine mammals are discussed in detail in Section 4.4.1.8.3.2.9. This alternative is not anticipated to have a direct effect on greenhouse gas emissions.

4.4.2.8.3.2. Cumulative Effects Under Alternative 2. Cumulative effects consist of the combined effects of past, present, and reasonably foreseeable events (Section 4.4.1.8.3.2) and the direct and indirect effects of this alternative. The only difference between the cumulative effects under Alternative 1 and Alternative 2 are those direct and indirect effects anticipated to result under Alternative 2 (Section 4.4.2.8.3.1).

Overall, additional leasing under the proposed sales will continue an active program of oil and gas exploration and limited production in the Beaufort Sea OCS. Approximately the same number of OCS-related activities (especially vessel traffic and noise, aircraft traffic and noise, seismic survey noise) will occur under the proposed sales as are associated with the existing leases. Production from these existing leases and any new leases is not anticipated, but we evaluated the potential effects of production, including the potential for a large spill, and these effects closely approximate the levels of effects described for the previous lease sales. These effects are relatively small compared to the major effects anticipated to occur under a continued era of climate change in the Arctic.

We have identified the net environmental consequence under Alternative 2 according to species or species group below.

Ringed, Spotted, Ribbon, and Bearded Seals. The greatest impacts to ice seals would come from climate changes and the reduction of sea ice. Impacts from local community travel and subsistence activities are expected to continue at current levels. Disturbances to northern ice seals from increasing vessel, aircraft, and subsistence activities are expected to continue at current levels. These levels of disturbance should result in negligible to moderate levels of effect on ice seal populations in the Beaufort Sea analysis area. The greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The expected increase in traffic from tourism, research, and shipping, as well as the potential for OCS exploratory traffic, increases the potential for marine accidents, disturbances, and oil/gas spills. A spill could result in major adverse impacts on seal species in the Proposed Action area; however, it is likely that climate change would continue to be the main source for major impacts on ice seals.

We believe oil and gas exploration associated with this lease sale would have a negligible level of effect on northern pinnipeds in the Beaufort Sea. Close cooperation between NMFS, MMS, and OCS operators will help ensure the level of effect does not increase.

Overall, a minor level of effects to ice seals should result under Alternative 2 in the Beaufort Sea. While this alternative does occur in habitat used by ringed, bearded, spotted, and ribbon seals, proper mitigation should greatly reduce the impacts associated with offshore oil and gas exploration. The existing level of effects as explained in the discussion for Alternative 1, indicates that the main source for adverse population-level effects to northern ice seals likely would be climate change and the coinciding changes to sea-ice quality and quantity in the Arctic. These climatic changes are expected to result in a major level of impact to ice seals in the Beaufort Sea. Consequently, we derived our cumulative level of effect by combining the overall direct and indirect effects under this alternative, which is a minor level of effect, with the existing condition under Alternative 1, which a major level of effect. Hence, the cumulative effects under Alternative 2 would constitute a major level of effect on ice seals in the Beaufort Sea.

Pacific Walrus. The Proposed Action area in the Beaufort Sea currently is at the edge of commonly used walrus habitat, and the proposed Beaufort Sea lease sales are expected to have negligible effects on walrus. Continued monitoring of walrus distribution and monitoring of physical parameters such as fecundity, contaminant loads, parasite loads and other measures of health, would allow managers to identify problems as they arise and would supply the information needed for effective adaptive

management plans. Pacific walrus currently are experiencing tremendous changes in their habitat due to ongoing trends in climate change. Ongoing changes in sea-ice distribution temporally and spatially may lead to changes in walrus distribution and may have major population-level effects.

Beluga Whale. There may be small increases in vessel and aircraft activity associated with new leases from the proposed sales over existing levels within the Beaufort Sea lease-sale area. Close cooperation between MMS, NMFS, and OCS-operators will help ensure that no more than a negligible level of effect occurs. Any exploration or production activities also would be conducted in a manner consistent with the MMPA. Overall, the oil and gas exploration activities are anticipated to have a negligible level of effect on beluga whales in the Beaufort Sea lease area.

An expected increase in traffic from tourism, research, and shipping would increase the noise in the marine environment and potential for marine accidents and oil spills. The greatest potential effect to beluga whales would be the unlikely event of a large oil spill occurring within the spring lead system at a time and place when migrating beluga whales could contact fresh oil. The impacts to beluga whale subsistence activities from non-OCS-related vessel traffic are expected to continue at current levels. The greatest potential for a major level of effect on beluga whales in the Chukchi Sea could result from changes in the physical environment associated with arctic warming/climate change.

Gray Whale. We anticipate the effects of proposed OCS oil and gas operations in the Alaskan Arctic on nonendangered baleen whales are similar to those described for ESA-listed whales. If the proposed lease sale is held, there are past and existing environmental changes and conditions that may be sources of adverse effects to gray whales, which are discussed in Section 4.4.1.8.1.7.7. These are expected to persist, and effects under the Proposed Action would be additive to them. Activities beyond MMS authority may or may not be subject to mitigation measures or, in the case of commercial and private vessel traffic, aircraft traffic and climate change be subject to limited or no direct regulatory or mitigation measures regarding gray whales.

Climate change may create positive and/or negative effects to non-ESA-listed beluga and gray whales, but these changes remain unpredictable at this time. Human activities, such as increased vessel traffic and noise addition to the marine environment, could prevent effective gray whale access to high-quality prey concentrations. Frequent encounters and exposure to noise disturbance could reach levels of chronic and cumulative stress to some animals so as to impact health, social bonds, and productivity of individuals. It would be speculative to determine the magnitude, distribution, intensity, and duration of such activities at this time.

Small or large oil spills associated with existing leases, prelease activities, and postlease activity from Sales 209 and 217 could occur as well as spills from past, present, and foreseeable activities (e.g., shipping, military operations, cruise ships, refueling, vessel collision and grounding, State oil and gas activity, aircraft crashes, etc.) not authorized by MMS. Potential climate change-induced increases in numbers of gray whales using the Beaufort Sea, changes, and/or expansion in seasonal distribution and range could increase potential exposure of these whales to oil in the event of spills. Whales exposed to spilled oil may experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, ingestion of contaminated prey items, baleen fouling, reduced food resources, or temporary displacement from feeding areas. A few individuals could be killed, temporarily or permanently experience sensory or physical impairment or tissue contamination as result of exposure to freshly spilled oil; however, the chance of a spill occurring and also contacting occupied gray whale habitat is considered very low. Whales tend to avoid vessel traffic, noise, and human activity, and the percentage of the Eastern North Pacific Stock of gray whales affected is very low in the Beaufort Sea. Mitigation measures associated with foreseeable OCS exploration, development, and production, and with

existing offshore lease areas, are expected to avoid or minimize adverse effects to gray whales. Alternative 2, the Proposed Action, would result in a negligible level of effect to gray whales in the Beaufort Sea.

4.4.2.9. Terrestrial Mammals. In the following analysis, we determined that there likely would be few direct or indirect effects if the lease sales were conducted—there would be negligible effects from vessel presence and noise, aircraft presence and noise, seismic airgun noise, petroleum spills, vehicular traffic, subsistence hunting, habitat loss, and gravel mining. While the greatest potential for major effects is associated with continuing physical changes in the arctic environment, the lease sales will not result in a direct effect on this impact category. The direct and indirect effects of this alternative were combined with the cumulative effects from Alternative 1, and the resultant levels of effect are the same as for Alternative 1. Mitigation measures imposed by MMS on future exploration and development activities on existing or new leases and surrounding waters avoid or minimize adverse effects to terrestrial mammals in the Beaufort Sea region. While MMS actions likely would result in an incremental increase in or longer duration of some activities, the total effect would be miniscule when compared to other unrestricted activities in the area.

This analysis identifies the anticipated level of effect for this alternative on terrestrial mammals. The anticipated effects of this alternative are separated into direct and indirect effects (Section 4.4.2.9.4) and cumulative effects (Section 4.4.2.9.5).

4.4.2.9.1. Potential Effects to Terrestrial Mammals. The potential effects to terrestrial mammals along the Beaufort Sea were described in Section 4.4.1.9.1 and are not repeated here.

4.4.2.9.2. Mitigation Measures. Mitigation is the same as those described in Section 4.4.1.9.2, and any applicable mitigations are described in Section 2.2.

4.4.2.9.3. Anticipated Effects Under Alternative 2.

Terms used to define a level of effect. We used the terms negligible, minor, moderate, and major to describe the relative degree or anticipated level of effect of an action on terrestrial mammals. Following each term below are the general characteristics we used to determine the anticipated level of effect. For all terms, best professional judgment was used to estimate population size when current or precise numbers were not known.

Negligible: Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year. No mortality is anticipated. Mitigation measures implemented fully and effectively or not necessary.

Minor: Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year or localized effects that are anticipated to persist for more than 1 year. Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population. Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable. Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate: Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than 1 year, but less than a decade. Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local postbreeding population, which may produce a

short-term population-level effect. Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are short term but more widespread.

Major: Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer. Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local postbreeding population, which could produce a long-term population-level effect. Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects. Unmitigatable or unavoidable adverse effects are widespread and long-lasting.

4.4.2.9.3.1. Direct and Indirect Effects Under Alternative 2.

Summary. Oil spills may result in the ingestion, inhalation, or exposure of terrestrial mammals to crude oil. What information we have suggests physiological stress or damage may occur as an effect of contacting or ingesting crude oil. Ingesting contaminated food items has been linked to liver damage, kidney damage, and respiratory damage in some cases.

The temporary displacement of a small number of caribou, muskox, grizzlies and furbearers from preferred habitats may occur. Chronic disturbances can have moderate effects over time; however, mitigation currently in place is expected to moderate potential impacts to terrestrial mammals. Disturbances that do occur are expected to be brief, producing negligible effects on the fitness and survival of most terrestrial mammal species.

Seismic activity appears to present no impacts to terrestrial mammals. Vibroseis activities are temporary and may displace the occasional terrestrial scavenger or hunter on the sea ice. Both vibroseis and seismic surveys should have no impacts on grizzly bears, caribou, or muskoxen in the Proposed Action area.

Vessel traffic in the Beaufort Sea is assumed to present a very minor level of disturbance during the ice-free season. Activity from icebreakers may pose a low threat to furbearers foraging on the sea ice by cutting off their avenues of moving to and from the sea ice.

Vehicular traffic associated with offshore oil and gas exploration may include snowmachines, rollagons, snowcats, ATV's, and automobiles in some areas. Considering the stringent regulations governing vehicle use by the oil and gas industry, only transient disturbances with negligible effects are expected under Alternative 2.

Aircraft traffic has been identified as a strong source of disturbance to caribou, muskoxen, grizzly bears, etc. Studies have indicated maintaining an altitude no less than 1,500 ft should greatly mitigate any adverse effects to terrestrial mammals might otherwise occur. Moreover the ADNRC (1999) requires oil and gas operators to maintain an altitude of 1500 feet on Alaska's North Slope, including the Proposed Action area.

4.4.2.9.3.1.1. Anticipated Effects from Vessel Presence and Noise. The anticipated effects from vessel presence and noise are the same as those described in Section 4.4.1.9.3.2.1.

4.4.2.9.3.1.2. Anticipated Effects from Aircraft Presence and Noise. The number of aircraft using the Proposed Action area is expected to increase above the expectations outlined in Section

4.4.1.9.3.2.2. Adhering to mitigations should keep any adverse impacts to a negligible level of effects. Increased aircraft presence and noise are expected to continue to have negligible levels of effects on terrestrial mammal species, if a 1000-foot flying altitude is maintained.

4.4.2.9.3.1.3. Anticipated Effects from Vehicular Traffic. The anticipated effects from vehicular traffic are the same as those described in Section 4.4.1.9.3.2.3.

4.4.2.9.3.1.4. Anticipated Effects from Subsistence. The anticipated effects from subsistence are the same as those described in Section 4.4.1.9.3.2.4.

4.4.2.9.3.1.5. Anticipated Effects from Gravel Mining. The anticipated effects from gravel mining are the same as those described in Section 4.4.1.9.3.2.8.

4.4.2.9.3.1.6. Anticipated Effects from Petroleum Spills. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect small numbers of terrestrial mammals because of their ability to spread and persist in the food web. Exposure of terrestrial mammals to petroleum or other hydrocarbons could result from a number of ongoing or future events. Such an event might occur when caribou wade into the coastal shallows seeking relief from swarms of biting flies and mosquitoes. Grizzlies and furbearers are most likely to directly encounter oil spills when scavenging the carcasses of dead marine mammals. Trophic effects may occur through ingesting oil while grooming or by feeding on contaminated food items. Ingestion of oil can lead to renal failure, liver failure, reproductive failure, or a host of other physiological side effects (Oritsland et al., 1981).

Petroleum spills may occur as a result of ongoing industry activities, barge and other vessel traffic, accidents at sea, accidents onshore, equipment malfunctions, spills during bulk fuel transfers, local village activities, or research activities. Most spills are expected to be of refined materials (diesel fuel, gasoline, antifreeze, etc.) and to be very small (Section 4.3.2.2).

Freshly spilled oil contains high levels of toxic aromatic compounds that can cause serious health effects or death if inhaled. Oil that moves some distance from a site may still have high levels of toxic aromatic compounds, depending on temperature and whether the oil becomes frozen into ice. Oil and other petroleum products are highly toxic when ingested. Petroleum products also can foul fur, leading to hypothermia.

Oil spills have a great potential for affecting terrestrial mammals in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice and weather conditions. Indirect effects to furbearers due to a spill include the possibility of local reductions in food items (seal pups, winter carrion on sea ice). The NRC has determined that a major spill in the Beaufort Sea would have major effects on polar bears and ringed seals (NRC, 2003b).

A large spill event associated with OCS oil and gas activities likely would occur only during the production phase, when volumes of oil or gas product is being moved to production facilities in the existing facilities at Kuparuk or Prudhoe Bay. Section 4.4.1.6.2.3.2 describes the basis for concluding that oil or gas production resulting from the proposed lease sales is considered speculative, and production effects are not considered reasonably foreseeable. Such a commercial discovery warranting production has not been identified or proposed for development and is considered speculative at this time. In other words, while MMS acknowledges that a large spill could have major impacts on terrestrial mammals, a spill from production activities is not considered a reasonably foreseeable future event.

The MMS models large spills to estimate the percent chance that a large spill could contact important resources, and then analyzes the potential effects from oil spills to determine which areas have the highest chance of contact from a specific geographic location. In the following sections we evaluate the vulnerability of caribou, grizzly bears, and furbearers, as a group, to large oil spills (oil-spill analysis), then we describe the effect of disturbance from oil-cleanup activities, the effects of prey reduction or contamination, and the anticipated effects of that mortality on these terrestrial mammal populations.

Vulnerability of Terrestrial Mammals to Oil Spills.

Caribou. The Teshekpuk Lake (TCH) and Central Arctic (CAH) caribou herds calve in areas adjacent to the coast on the Alaskan Beaufort Sea (Figure 4.4.2.9-1). These sites near the coast occur in the relatively flat coastal plain, which is riddled with shallow lakes, ponds, streams, and puddles, all of which create ideal breeding habitat for mosquitoes. These hordes of biting insects have been known to force caribou onto barrier islands or into the surf in an effort to gain relief from their torment. After physically encountering oil, an individual animal's coat will become slicked with oil, resulting in a loss of thermal protection and subsequent hypothermia. Mammals typically respond to a filthy coat by licking it clean, a behavior that will result in the ingestion of oil by the individual caribou. Consequently, the caribou stands a strong likelihood of going into renal failure, liver failure, neuromuscular degeneracy, and a quick death. Any mortality associated with a large oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use and stage of annual cycle at the time of contact (e.g., wintering individuals vs. calving individuals vs. migrating individuals).

Grizzly Bears. Barren ground grizzlies are known to occupy various portions of this area. While >80% of their diet consists of vegetative matter, these are an opportunistic species that will prey on other animals and actively scavenge as the opportunity presents itself. The primary risk to the grizzly would occur in the event of a large oil spill that kills off large numbers of marine mammals and fishes. There exists a very possibility that grizzlies from a large area would smell the rotting carrion and rapidly make their way to the carcasses. After feeding on the contaminated carcasses, there is a chance that the bears will physically encounter a portion of the spill, contaminating their fur. Consumption of the contaminated carcasses and grooming would result in oil ingestion by the bear, which may easily lead to hypothermia, renal failure, liver failure, reproductive failure, other physiological problems, and eventual death. A large oil spill that occurs during winter most likely would not have any immediate effects on the grizzly population, providing adequate cleanup is completed before the bears wake from hibernation. Any mortality associated with a large oil spill is likely to reflect local population size and vulnerability determined by seasonal habitat use, sex, and stage of lifecycle at the time of contact (e.g., males vs. female with cubs, migrating caribou vs. runs of salmon).

Furbearers. Wolves, wolverines, and arctic and red foxes are addressed here because they all exhibit some similarities in their scavenging and hunting behaviors. The effects of a furbearer ingesting or becoming physically exposed to a large oil spill are the same as for the grizzly bear. There would be a much greater chance of arctic or red foxes coming in contact with a large oil spill or contaminated food, because they tend to occur and higher population densities than bears, wolves, or wolverines. Furthermore, arctic foxes are well known for denning under facilities and near developments in the Arctic. Consequently, any large spill that occurs near onshore facilities and that result in a marine mammal, bird, or fish die off will draw in foxes and other scavengers. The physiological effects of ingesting or coming into direct contact with oil would be the same as for bears. Unlike grizzly bears, the furbearers remain active throughout the winter, often roaming well out onto the sea ice to scavenge kills or to hunt seal pups. This could place them into relatively close proximity to offshore developments in the landfast ice and food items that ingested oil in quantities that were too small to result in death. There exists a strong possibility of the bioaccumulation of oil-derived contaminants in furbearers scavenging

and hunting on the winter sea ice, and no information is available relating to their ability to cope with sub-lethal amounts of these toxins. However, effects resulting from scavenging on sea ice will diminish and disappear with the projected reduction in, and then disappearance of, the winter sea ice sometime during the next 40 years although, oiled carcasses may wash ashore as a result of a spill event.

4.4.2.9.3.1.6.1 Oil-Spill Analysis. The potential for large spills to contact terrestrial mammal species in the Beaufort Sea was described in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS, 2003a). Due to small adjustments in the environmental resource areas, lease-sale area, and other model refinements, we have updated the assessment for the proposed Beaufort Sea lease sales below. The results of this analysis are much the same as those for the previous multiple lease sales in the Beaufort Sea.

Conditional Probabilities-Large Oil Spill. The following discussion summarizes LAs 1-25 and PLs 1-17 during summer or winter unless otherwise specified.

Summer Spill. The OSRA model estimates that the chance of a large spill originating from launch areas or pipeline segments contacting land segments important to terrestrial mammals. Some caribou of the CAH, TCH, WAH, and PCH herds frequent coastal habitats from Demarcation Bay (LS111) west to Point Barrow (LS85). The OSRA model estimates the chance of a large spill from launch areas contacting individual LSs 85-111 within 30 days ranges from <0.5-18% (Table A.2-77) and from <0.5-19% from pipeline segments (Table A.2-78).

Coastline habitats from Barrow, Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (LSs 85, 86, 88-93 and coastline habitats in the Kaktovik area LS107) have the highest chance of contact, >10% up to 16%, from either LAs 1- 8 or PLs 1-9, assuming spills occur during the summer season within 30 days (Table A-77 and 78). Assuming a spill occurs from LA6, north of the Teshekpuk Lake Special Use Area (TLSUA), there is a 46% chance that a spill would contact the shoreline of the special use area (LSs 89-93) within 30 days during the summer open-water season (Table A.2-89). Assuming a spill occurs within L18 offshore of ANWR, there is up to a 51% chance that a large spill would contact the shoreline (GLS138) within 30 days during the summer open-water season (Table A.2-89).

Winter Spill. The OSRA model estimates that the chance of a large spill originating from launch areas contacting land segments important to terrestrial mammal habitat. Some caribou of the CAH, TCH, WAH, and PCH frequent coastal habitats from Demarcation Bay (LS111) west to Point Barrow (LS85). The OSRA model estimates the chance of a large spill from launch areas contacting individual LSs 85-111 within 180 days ranges from <0.5-12% (Table A.2-129) and from <0.5-9% from pipeline segments (Table A.2-130).

Coastline habitats from Barrow, Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (LSs 85, 86,88-93), and coastline habitats have the highest chance of contact, >9% up to 12%, from either launch areas or pipeline segments, assuming spills occur during the summer season within 180 days (Table A-129 and 130). Assuming a spill occurs from LA6, north of the TLSUA, there is a 23% chance that a spill would contact the shoreline of the special use area (LSs 89-93) within 180 days (Table A.2-141). Assuming a spill occurs within LA18 offshore of ANWR, there is up to a 34% chance that a large spill would contact the shoreline (GLS 138) within 180 days (Table A.2-143).

Combined Probabilities-Large Oil Spill. The chance of one or more large spills occurring and contacting important terrestrial mammal habitat (LSs 85-111) is <0.5% within 30 days. Within 180 days it ranges from <0.5-1%.

Chronic Low-Volume Spills. Small or low-volume spills are defined as being <1,000 bbl. The average crude oil spill size is 126 gal (3 bbl) for spills <500 bbl. An estimated 89 small crude oil spills would occur during the 20-year oil-production period (Appendix A, Table A.1-30), an average of more than 4 per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 220 refined-oil spills would occur during the 20-year oil-production period (Appendix A, Table A.1-35), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur over the 20 years of production.

It is unknown how many small-volume spills or what total volume would affect areas used by caribou, or how much contaminated carrion would be available for grizzly bears or furbearers.

Spill-Response Activities. None of the conditional or combined probabilities factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Activities such as hazing and other human activities (vessel and aircraft traffic) could impact caribou, muskoxen, grizzly bears, and furbearers. During the ice-free months, hazing likely may prevent the death of some terrestrial mammals in the contaminated area. Although hazing would have an immediate detrimental effect on an individual animal, the long-term benefit (preventing an oil-related mortality) could partially compensate for the effects of the disturbance.

The presence of large numbers of cleanup workers, boats, and additional aircraft is likely to displace caribou, muskoxen, wolves, and wolverines around affected coastal habitats during open-water periods for one to several seasons. The same does not hold true for arctic and red foxes, which easily habituate to human activity. However little direct mortality from cleanup activity is likely. Disturbance during the initial season, possibly lasting 6 months, could be expected in some areas.

Oil-spill response could originate from as far away as Deadhorse, about 150 mi east of Barrow. Specific animal-deterrence activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with MMS, landowners, and State officials on wildlife-management activities in the event of a spill. In an actual spill, the three aforementioned groups may have a presence at the Incident Command Post to review and approve proposed hazing activities and monitor their impact on terrestrial mammals.

The OSRPs typically do not spell out specific wildlife-response actions. Oil-spill-response plans typically identify the resources at risk and refer to the appropriate tactics. The response contractor also can contract with other response organizations to augment animal hazing and response activities. The response contractor would be expected to have knowledge of scare tactics in addition to an inventory of equipment (air cannons, guns, pyrotechnics, vessels, and visual devices) to deter terrestrial mammals from entering the spill area or approaching carcasses, and it would be assumed they would cycle their use to ensure that the animals do not habituate to their effect.

For purposes of evaluating the potential impact of a large spill on terrestrial mammal species, oil-spill response in the Beaufort Sea is assumed to be ineffective due to the unpredictability of response time and certain environmental conditions (e.g., broken ice, weather).

Prey Reduction or Contamination. Local reduction or contamination of food sources could reduce survival or reproductive success of the grizzly bear and furbearer populations occupying the local area. However, the contamination of some local habitat areas is not likely to affect a large proportion of the

grizzly bear, wolf, or wolverine population, because they are highly territorial with large home ranges and have access to similar resources away from the spill site.

Impacts to arctic and red fox populations could be more severe, considering their higher population densities, particularly in and around onshore oil field developments. Furthermore, they are notorious for caching surplus foods for late-season and winter use. Moreover, the smaller size of the foxes could make them more prone to dying after ingesting smaller quantities of oil.

Furbearers scavenging or hunting seal pups on the sea ice may see a decrease in the quantity of seal pups or available marine mammal carcasses. This would place undue stresses on these furbearers at a very crucial season, when they are already nutritionally stressed to their limits. With the anticipated retreat of winter sea ice away from the Beaufort Sea coast, this winter scavenging issue eventually might lose relevance, since routes to and from the sea ice may disappear earlier in the spring and develop later in the fall.

Anticipated Mortality from an Oil Spill. The chance of oil exposure to caribou would occur if a large oil spill eventually drifted to the coastline while caribou were resting in the surf. While unlikely, such an event is conceivable and must be addressed. If oil cleanup and/or hazing could be initiated quickly, the losses from such a spill would be greatly minimized for all terrestrial mammals. Furthermore, the monitoring for and removal of contaminated carrion would have to be incorporated into the response action. By collecting dead carcasses at sea and on the shoreline, the attractants for furbearers and bears will be removed, providing no reasonable likelihood of grizzly bear or furbearer exposure to the spill.

To put the chance of a large spill having population-level impacts in perspective, one has to consider several variables. First, to ever have an oil spill, production would have to occur. Second, the location of the oil or gas find and subsequent development platform could influence the probability that a spill would occur as well as the probability that it would reach resource areas important to terrestrial mammal species when the species are present or, in the case of a winter spill, when those furbearers encounter contaminated carrion or seal pups.

Anticipated mortality associated with these modeled events would represent a statistically insignificant number of North Slope caribou, grizzly bears, or furbearers. The MMS requires companies to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment. This situation has not changed. Similarly, smaller spills would have even less likelihood of reaching these areas. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of a significant number of terrestrial mammals on the North Slope is extremely low. Considering the low probability of a large spill coupled with a variety of other factors that would need to be satisfied to result in mortality, MMS anticipates that it is highly improbable that a significant amount of terrestrial mammal mortality would result from oil spills associated with the Proposed Action, and negligible effects are expected. Any oil spills that arise as a result of selecting alternative 2 are expected to produce a negligible level of effects on terrestrial mammals in the Proposed Action area.

4.4.2.9.3.1.6.2 Cumulative Effects Under Alternative 2. In addition to the nonproject-related impacts of global warming as outlined in Section 4.4.1.9.1.9., an increase in the levels of icebreaker/aircraft/vehicular traffic, gravel mining, and oil spills are likely to occur. Icebreaker activity could create leads, which may fragment the areas of sea ice available for hunting and scavenging by furbearers, however these impacts would probably affect an extremely small number of terrestrial mammals and are not expected to result in any mortalities. Gravel mining could alter river habitat;

however, it is unlikely to disturb a large number of grizzly bears or other terrestrial mammals considering the localized scale of the activity and the fact that existing mitigation is mandated by the State of Alaska (ADNR, 1999). Recommendations for aircraft to operate at or above an altitude of 1,500 ft would greatly mitigate disturbances that otherwise could elicit injurious reactions in wildlife. Any additional oil and gas-related vehicle use onshore would create brief and transient impacts with a short duration and negligible level of effect as long as it continues to be limited by regulation and mitigation.

Anticipated mortality associated with the modeled oil-spill events could affect muskoxen, caribou, grizzly bears, or furbearers. However the MMS requires companies to have and implement OSRPs to help prevent oil from reaching critical areas and to remove oil from the environment. This situation has not changed. Similarly, smaller spills would have even less likelihood of reaching these areas. Oil-spill modeling indicates that the percent chance of a spill of a magnitude that could jeopardize the continued existence of a significant number of terrestrial mammals on the North Slope is extremely low. Considering the very low probability of a large spill occurring coupled with sea ice conditions, and existing OSRP's, the MMS believes that it is highly unlikely that terrestrial mammal mortality would result from oil spills associated with the Proposed Action, and negligible effects are anticipated.

The preponderance of evidence and study data indicates climate change will continue to pose the greatest challenge for terrestrial mammals living near the Beaufort Sea coast and the Proposed Action area. Under Alternative 2, we expect exploration activities to occur in the foreseeable future. Most terrestrial mammals maintain enough flexibility to adapt to transient perturbations in their environment over time. Adequate mitigation efforts also will go a long way towards lessening the impacts of oil and gas surveys in the analysis area. Consequently, Alternative 2 is expected to have an added negligible level of effect on terrestrial mammals in the Beaufort Sea Proposed Action area in addition to the expected major level of impacts that are expected to occur as a result of climate change, subsistence harvesting, and unregulated vehicle traffic. Alternative 2 is expected to have only a negligible level of effect on greenhouse gas emissions.

4.4.2.10. Vegetation and Wetlands.

Summary. Vegetation and wetlands might be affected by additional construction and possible spills as a result of the proposed lease sales. The footprint of development facilities is estimated to affect 33 km² (8,327 acres) of tundra vegetation and wetlands—a minimal effect on the North Slope. If a spill occurs during the spring tides or during storm tides, oil might be deposited above the level of normal wave activity. In such a case, stranded oil is expected to affect only a small amount of the emergent vegetation but to persist for long periods due to low rates of dispersion and degradation.

4.4.2.10.1. Potential Effects to Vegetation and Wetlands Under Alternative 2. Vegetation and wetlands in the Beaufort and Chukchi seas are subject to the same potential effects described for Alternative 1, no-action alternative (Section 4.4.1.10.1). These potential effects are not repeated here. Also, potential effects on vegetation and wetlands were assessed in the previous Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003: Sec. IV.C.9). The assessment concluded that there would be local construction effects, and that stranded oil on peat shorelines likely would persist for many years.

4.4.2.10.2. Mitigation Measures. The potential effects can be moderated by the mitigation measures listed in Section 4.4.1.10.2.

4.4.2.10.3. Anticipated Effects Under Alternative 2. The following analysis describes anticipated effects to vegetation and wetlands that are most likely to occur if MMS conducts Lease Sales 209 and 217 in the Beaufort Sea. The potential effects of certain activities were presented in Section 4.4.1.10.1. In

this section, we describe the anticipated effects on vegetation and wetlands under the Proposed Action. These anticipated effects consider mitigation measures described in 4.4.1.10.2.

4.4.2.10.3.1. Anticipated Effects from Construction Activities. Exploration construction is expected to have little to no adverse effects on vegetation and wetlands. Permanent loss of tundra vegetation and wetlands would only arise from the construction of development and production facilities (pipeline landfall to an onshore base, pipeline linking to existing infrastructure) and are not considered reasonably foreseeable at this time.

Should production be proposed, mitigation measures imposed on future facilities would avoid or minimize adverse effects to tundra vegetation and wetlands adjacent to the Beaufort Sea. Furthermore, future filling of wetlands would be subject to U.S. Army Corps of Engineers permitting processes.

Impacts on tundra vegetation and wetlands would arise from footprints associated with construction of facilities in support of oil and gas activities. The MMS can only speculate about the size and location of permanent onshore developments associated with a future phase of oil production, but they were estimated (Table 4.4.1.10-1). Overall, these developments are estimated to have a direct footprint of 3.41 km² (845 acres) of possible tundra vegetation and wetlands. Overall, these zones of influence associated with development facilities have an estimated collective area extent of 33 km² (8,327 acres).

4.4.2.10.3.2. Anticipated Effects from Discharges and Oil Spills. Discharges from small spills are expected to be minimal and could consist of small quantities of diesel, gasoline, and hydraulic fluid spilled during maintenance and operation of equipment on suspended wells or bottom-founded platforms. A pollution-prevention plan to minimize discharges directly into the water would be implemented. Due to the potential low quantities of these discharges, negative impacts on shoreline vegetation communities would be negligible.

Due to amendments in the OCS Lands Act, strong safety and pollution-prevention regulations, and the use of blowout-prevention equipment installed on seabed wellheads, the potential for oil spills has diminished greatly. Therefore, impacts on shoreline vegetation would be expected to be low as a consequence of the implementation of these prevention measures. Another reason for diminished impacts of shoreline vegetation resulting from oil spills would be the distance from the shoreline in which the exploration activities take place.

If a large spill occurred offshore, the OSRA model estimates the chances of such a spill reaching the Beaufort Sea coast within 10 or 30 days is up to 13 and 23%, respectively, from launch areas and pipeline segments (Tables A.2-39-42). Table A.1-5 shows the percent type of shoreline closest to the ocean. The OSRA model estimates the chance of contact to individual land segments with estuaries and salt marshes (ESI 9 or 10; LSs 87-111) along the Beaufort Sea ranges from <0.5-5% within 10 days and <0.5-7% within 30 days over the entire year (Tables A.2-15-18). For combined probabilities, the OSRA model estimates the chance of one or more large spills occurring and contacting LSs 87-111 is <0.5% within 10 and 30 days.

If the large spill occurred close to the shoreline, the chance of adverse impacts on the estuaries and salt marshes would depend on wind and wave conditions. However, when spills occur in open water, the potential for a quick response is higher. In situ burning, booming, and skimming operations would be effective means to prevent oil spills from reaching sheltered bay where estuaries and salt marshes typically are found. Due to the low tidal range typical in such environments, stranded oil would be subject to low rates of abrasion and dispersal by littoral processes. The effect of any oil deposited below the tide line is assessed in the section on lower trophic-level organisms (Sec. 4.4.2.3). Oil deposition

above the level of normal wave activity would occur, if the spill takes place during the spring tides or during storm surges. In such a case, oil stranded in emergent vegetation is expected to persist for long periods due to the low rates of dispersion and degradation. Impacts would include the destruction of emergent vegetation, if slick oil sinks into the root system (Owens, 1977).

4.4.2.10.3.3. Anticipated Effects from Changes in the Physical Environment. The Cumulative effects from global forces are the same as those described in Section 4.4.1.10.3. Effects occurring resulting from changes to the physical environment are ongoing independent of lease-sale activity.

Conclusions - Effects Under Alternative 2 to Vegetation and Wetlands.

4.4.2.10.4. Direct and Indirect Effects Under Alternative 2. The adverse effects on tundra vegetation and palustrine wetlands from routine exploration activities are expected to be negligible.

Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on tundra vegetation and wetlands, if such a discovery is made and proposed for development in the more distant future. Such production-related activities include effects on tundra vegetation and palustrine wetlands due to construction of development/production facilities and the potential for oil spills.

4.4.2.10.5. Cumulative Effects Under Alternative 2. By definition, Lease Sales 209 and 217 likely would result in an increase in the number of leases in the Beaufort Sea OCS. Some of the existing leases will not be explored and will not be evaluated further by the time the lease lapses. While there may be an initial increase in the number of active leases following a sale, there will be a gradual decline in active leases over time. Exploration activities could continue at existing levels due to a limited number of specialized/suitable vessels for conducting these activities. This level of activity would represent a continuation of the same level of effect as described for anticipated Federal oil and gas activities under the Reasonably Foreseeable Future Events (Section 4.2.1), except that these activities likely would extend further into the future as new leases are granted. While Federal actions likely would result in an incremental increase in some sources of potential impacts, required mitigation measures would limit these sources to proportionately fewer impacts compared to other unrestricted sources of impact in this area.

Impact to tundra vegetation and palustrine wetlands are likely to continue from community and onshore oil and gas infrastructure, which are unrelated to OCS leasing activities. The greatest threat of oil-spill impacts on wetlands would continue to arise from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase dramatically the potential for marine accidents and large fuel spills, which could result in major adverse effects on coastal wetlands adjacent to the Beaufort Sea.

Conclusion. The footprint of development facilities is estimated to affect 33 km² (8,327 acres) of tundra vegetation and wetlands—a minimal effect on the North Slope. If a spill occurs during the spring tides or during storm tides, oil might be deposited above the level of normal wave activity. In such a case, stranded oil is expected to affect only a small amount of the emergent vegetation, but to persist for long periods due to low rates of dispersion and degradation.

4.4.2.11. Economy.

Summary. The typical Beaufort sale would generate increases in NSB property taxes that would average about <2% above the level of NSB revenues without the sales in the peak years. In the early years of production, the sale would generate increases in revenues to the State of Alaska of <0.003% above the same level without the sale. The peak years of production would generate increases in revenues to the Federal Government of <0.02% above the level without the sale. For the NSB, State of Alaska, and the Federal Government, the increases would taper off to even smaller percentages in the later years of production. The change in total employment and personal income would be <0.9% over the baseline for the NSB and the rest of Alaska for each of the three major phases of OCS activity. Assumed large oil spills of 1,500 bbl or 4,600 bbl would generate 60 or 90 jobs respectively for 6 months the first year, declining to zero by the third year following the spill. A typical Beaufort sale would contribute to extending the lifespan of the TAPS.

The Impact Descriptor for economics is: Economic effects that would cause important and sweeping changes in the economic wellbeing of the residents or the area or region. Local employment is increased or decreased by 10% or more for at least 2 years. Economic wellbeing of residents is the ability of individuals and families to meet basic needs which include food, clothing, housing, heat, and subsistence.

Introduction. We assume all of the alternatives for the Beaufort Sea, except Alternative I - No Lease Sale, have the same amount of oil and/or gas and similar levels of activity among alternatives. Therefore, the economic effects to communities and to the State of Alaska are essentially the same. A typical Beaufort sale would generate economic activity manifested primarily in revenue to government, employment, and personal income. The economic effects would be in the NSB, Southcentral Alaska, Fairbanks, and the rest of the U.S. We use the exploration and development scenario in Table B-4 for 500 MMbbl in Appendix B to forecast employment and personal economic effects. The reader should refer to Appendix B for a description of timing of OCS activity including infrastructure of wells, rigs, platforms, pipelines, and shore bases. The activities and construction and operation of infrastructure described in the exploration and development scenario generate the economic activity. The summary above defines the impact descriptor for economics. The term “local employment” here means workers who are permanent residents of the NSB, both Inupiat and non-Inupiat, and does not include North Slope oil-industry workers who commute to residences within or outside of Alaska.

4.4.2.11.1. Revenues. A typical Beaufort sale would generate increases in NSB property taxes of <2% without the sales in the peak years and taper off to <0.4% in the later years of production. We assume NSB revenues to be \$270 million (see Section 3.4.1). The revenue to the NSB would be about \$10 million in the peak years of production, tapering off to \$1 million in the later years.

The peak years of production would generate increases in property tax revenues to the State of Alaska of <0.003% above the level without the sale. The revenue to the State would be about \$0.225 million in the peak years of production. The increases would taper off to even smaller amounts and percentages in the later years of production. The peak years of production would generate increases in revenues to the Federal Government of <0.02% above the level without the sale. The increases would taper off to even smaller percentages in the later years of production. The revenue to the Federal Government would be about \$425 million in the peak years of production, tapering off to \$40 million in the later years.

In this paragraph we explain the methods we used to calculate revenue effects. The property tax mill rate in the NSB is 18.5. The State collects 20 mills and returns 18.5 mills to the NSB. We assume new onshore pipelines costing \$1.5 billion (Craig, 2008, pers. commun.). We multiply the mill rate times \$1.5 billion with the result of approximately \$3 million. The NSB total revenue in the 2006/2007 budget is

\$270 million. \$3 million is <2% of \$270 million. The State of Alaska has authority to tax oil- and gas-transportation pipelines (AS 43.52.060; Greely, 2007, pers. commun.). Multiplying the State of Alaska mill rate of 1.5 by \$1.5 billion results in approximately \$0.25 million. The State budget for Fiscal Year 2008 is approximately \$8 billion. \$0.25 million divided by \$8 billion is 0.003%. We project the peak year of oil production is 55 MMbbl, we assume \$46/bbl, and we have a royalty rate of 16 2/3%. Multiplication of those three variables results in \$425 million. \$425 million divided by the 2008 Federal budget of \$2.5 trillion results in .02%.

4.4.2.11.2. Employment and Personal Income Not Related to Oil Spills. The forecast increase of total employment and personal income is shown in Table 4.4.2.11-1. The change is <0.9% over the baseline for the NSB and the rest of Alaska for each of the three major phases of OCS activity. We use the IMPAK Model (Jack Faucett Associates, Inc., 2000) to forecast the employment and personal income in Table 4.4.2.11-2. We describe baselines in Section 3.4.1. We use the variables from the Exploration and Development Scenario in Section 2.4.1. and related variables as inputs to IMPAK. Outputs are direct employment and personal income and indirect and induced employment and personal income.

The typical Beaufort sale would generate employment and personal income in three major phases: exploration, development, and production. In general, employment and associated personal income would be at a relatively low level in exploration, peaking during development, and dropping to a plateau in production. This pattern of economic effect reflects the exploration and development scenario described in Section 2.4.1. We assume all direct OCS workers work in enclaves on oil platforms on the OCS or onshore on the North Slope during their work time and commute to residences elsewhere in their time off. Their place of residence during the time they are not in an OCS worker enclave would be in villages of the NSB or in Southcentral Alaska or Fairbanks, as indicated in Table 4.4.2.11-2. Additional workers on the North Slope commute to residences outside the State. Approximately 30% of current North Slope workers in the classification of oil and gas workers commute to locations outside Alaska in 2001 and 2006 (Hadland, 2002, pers. commun.; Hadland and Landry, 2002; Hadland and Laurent, 2008).

Workers commuting to residences outside the State would not generate economic effects of indirect and induced employment or expenditure of income in the State, and they would have a negligible effect on the economy of the rest of the U.S. All of the commuting workers would be present at new OCS enclaves offshore or in associated enclave-support facilities onshore along the Beaufort Sea or in the Prudhoe Bay area approximately half of the days in any year. Abandonment, or decommissioning, of production facilities is technically an activity separate from production. However, for the sake of simplicity of presenting data in Table 4.4.2.11-1, production includes abandonment. Employment and personal income generated by abandonment would be small compared to production and would last only 2 years. The exploration and development scenario for a typical Beaufort sale indicates exploration activity would take place in 2008-2017, development activity in 2019-2026, and production in 2022-2038.

Typical Beaufort postsale has some overlap of the three main activities of exploration, development, and production. To simplify analysis but define the primary distinctions, we present data for employment and personal income as annual averages for the three main OCS activity categories. “Direct employment” includes those workers with jobs directly in oil and gas exploration, development, and production. “Indirect employment” includes those workers in industries that support the direct exploration, development, and production activities. These include jobs in transportation, such as shuttling workers by air between Anchorage and the North Slope. Direct and indirect workers spend a part of their earnings for expenses such as food, housing, clothing, etc. The aggregate of workers associated with providing those goods and services is termed “induced employment.” Each of the direct, indirect, and induced workers has compensation derived from their work termed “personal income” in Table 4.2.11-2.

4.4.2.11.3. Employment Related to Large Oil Spills. Assuming a large oil spill of 1,500 bbl, we estimate employment to be 60 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill. Assuming a large spill of 4,600 bbl, we estimate employment to be 190 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill. The 60-190 workers make up about 0.6-1.9% of the workers who cleaned up the EVOS. For assumptions of spill sizes, see Section 4.3.2.

Our estimate of employment to clean up spills is based on the most relevant historical experience of a spill in Alaskan waters, the EVOS of 1989. That spill was 240,000 bbl. It generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992.

Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Similar effects on the NSB would be mitigated due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would be located in existing enclave-support facilities. In the event of a 1,500- or 4,600-bbl oil spill, the number of workers actually employed to clean it up would depend on a number of factors. These include the procedures called for in the oil-spill-response plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities.

Trans-Alaska Pipeline. The typical Beaufort sale would produce 500 MMbbl of oil over 19 years of production. This oil would contribute to extending the useful life of the TAPS.

4.4.2.11.4. Mitigation Measures. The standard stipulations and ITL clauses would not change the effects analyzed.

4.4.2.11.5. Subsistence as a Part of the North Slope Borough Economy. The predominately Inupiat residents of the NSB traditionally have relied on subsistence activities. Although not fully part of the cash economy, subsistence hunting is important to the Borough's whole economy, and even more important to culture. For the analyses of effects on these activities, see Sections 4.4.1.12, Subsistence-Harvest Patterns and 4.4.1.13, Sociocultural Systems.

Conclusion. The typical Beaufort sale would generate increases in NSB property taxes that would average about <2% above the level of NSB revenues without the sales in the peak years. In the early years of production, the sale would generate increases in revenues to the State of Alaska of <0.003% above the same level without the sale. The peak years of production would generate increases in revenues to the Federal Government of <0.02% above the level without the sale. For the NSB, State of Alaska, and the Federal Government, the increases would taper off to even smaller percentages in the later years of production. The change in total employment and personal income would be <0.9% over the baseline for the NSB and the rest of Alaska for each of the three major phases of OCS activity. Assumed large oil spills of 1,500 bbl or 4,600 bbl would generate 60 or 90 jobs respectively for 6 months the first year, declining to zero by the third year following the spill. A typical Beaufort sale would contribute to extending the lifespan of the TAPS.

4.4.2.12. Subsistence-Harvest Patterns and Resources.

Summary. Disturbance and noise could affect subsistence species that include bowhead and beluga whales, walrus, seals, polar bears, caribou, fish, and birds. For the communities of Kaktovik, Nuiqsut,

and Barrow disturbances periodically could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt.

Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would be expected to avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on subsistence resources and subsistence-harvest patterns, producing major effects.

4.4.2.12.1. Anticipated Effects to Subsistence-Harvest Patterns. Subsistence-harvest patterns in the Beaufort Sea Planning Area are subject to the same potential effects described in Section 4.4.1.12.1.1-1.9 and the same cumulative past, present and reasonably foreseeable actions described in Sections 4.4.1.12.7. This section describes the impact on subsistence-harvest patterns resulting from the incremental impact of this action--the Proposed Action alternative--and adding it to other past, present, and reasonably foreseeable future actions regardless of what agency undertakes such actions. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures are described in Section 4.4.1.12.2.

4.4.2.12.1.1. Anticipated Effects From Vessel Disturbance. In comparison to the Bering Sea, current levels of vessel traffic in the Beaufort Sea Planning Area are low but increasing. Vessel traffic in the proposed lease sale area can be characterized as smaller vessels used for hunting and between-village transportation during the open-water period.

The types of vessels that typically produce noise in the Beaufort and Chukchi seas include barges, skiffs with outboard motors, icebreakers, tourism and scientific research vessels, and vessels associated with oil and gas exploration and development and production. In the Beaufort and Chukchi seas, vessel traffic and associated noise is typically limited to late spring, summer, and early autumn. Many essential items are transported to coastal villages and industrial sites via barges and smaller cargo vessels during the open-water period and include deliveries of machinery, fuel, building materials, and other commodities. The MMS anticipates that trends associated with this type of vessel traffic will continue indefinitely.

Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels. The use of aluminum skiffs with outboard motors during spring subsistence whaling also contributes noise. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a). In shallow water, vessels more than 10 km away from a receiver generally contribute only to background noise (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995a).

Icebreaking vessels used for activities including research and oil and gas activities produce stronger, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995a). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al., 1991). In some

instances, icebreaking sounds are detectable from more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

During the open-water season, vessels such as tugs, self-propelled barges, and crew boats were the main contributors to Northstar-associated underwater-sound levels, with broadband sounds from such vessels often detectable approximately 30 km offshore. In 2002, sound levels were up to 128 dB re 1 μ Pa at 3.7 km, when crew boats or other operating vessels were present (Richardson and Williams, 2003). In the absence of vessel noise, averaged underwater broadband sounds generally reached background levels 2-4 km from Northstar. Underwater-sound levels from a hovercraft, which BPXA began using in 2003, were quieter than similarly sized conventional vessels.

In 2006, Shell Offshore, Inc. proposed a 3-year exploratory program on their Federal leases in the Beaufort Sea (USDOI, MMS, 2007b). This program was stopped by court order in 2007 but could begin as soon as legal challenges are resolved. The Shell program would use tens of vessels to support this program, including spill-response vessels. An active seismic program also is proposed by BPXA in nearshore areas of the Beaufort Sea in 2008. The BPXA program proposes to use about 10 vessels, including a hovercraft during the open-water season in nearshore waters around the Endicott Causeway/Foggy Island Bay area (USDOI, MMS, 2008a). In addition, industry oil-response contractor, Alaska Clean Seas, periodically performs spill-response drills with response vessels and equipment.

Because of increasing vessel traffic in the Arctic, the U.S. Coast Guard is considering the possibility of establishing a seasonal forward operating base at Barrow to decrease long-range rescue expenses (U.S. Coast Guard, 2007). Vessel traffic overall is changing in the arctic seas as the open-water season occurs earlier and ends later and there is increased opportunity for shipping, research, and cruise-ship tourism. The MMS believes that an increase in this sort of vessel traffic is likely regardless of oil and gas activity.

Marine mammals important to subsistence also react to the physical presence of vessels; when they see vessels, they react to them. The intensity and distance to which marine mammals react are often related to previous experiences and the perceived vessel size, speed, and distance. Vessel traffic from exploration activities would include up to three seismic surveys per year, each survey employing one seismic vessel and a number of support vessels. For development and production, one to three vessel trips per/week per/platform (1-4 platforms anticipated for both Sales 209 and 217, respectively) would be anticipated.

Oil and gas exploration and development in the Beaufort Sea Planning Area could result in disturbance to marine mammal resources and harvests. Mitigation measures imposed by MMS on future exploration and development activities would be expected to minimize adverse effects to these resources. Vessel activities associated with the proposed action are anticipated to have a minor effect on marine mammal resources and subsistence harvests in the Beaufort Sea Planning Area.

4.4.2.12.1.2. Anticipated Effects From Aircraft Disturbance. Air traffic comes from (1) passenger airline service to North Slope communities; (2) air-cargo services moving cargo between North Slope communities and Anchorage and Fairbanks in Alaska and Yellowknife in Canada; and (3) intercommunity travel and freight hauling on the North Slope using commuter-type aircraft operated smaller air carriers. Government and university researchers sometimes charter aircraft for research projects. These activities are expected to continue. It is conceivable that aircraft activity directly associated with tourism and research could increase as a result of Arctic climate change.

Industry uses helicopters to support routine activities such as seismic surveys, crew changes at offshore sites, and to resupply remote camps and facilities. Aircraft traffic associated with existing leases on and offshore would continue. The increase in aircraft traffic resulting from exploration activity from Lease

Sales 209 and 217 likely would come mostly during the summer months in support of exploration activity associated with the lease sales. One helicopter flight per week per seismic operation (up to 3 per year anticipated) and one to three helicopter flights per/day per platform (1-4 platforms anticipated for both Sales 209 and 217, respectively) would be anticipated. Aircraft traffic associated with existing oil and gas activity onshore and in State waters also would contribute to increases in aircraft traffic. The MMS assumes that existing trends in aircraft traffic will continue in the absence of additional lease sales.

Low-level aircraft traffic could adversely affect marine mammals important to the subsistence harvest. Marine mammals react to the sound of an aircraft from hearing it, and some can react to simply seeing an approaching aircraft. The intensity and distance to which marine mammals react often are related to the size, speed, and distance of the aircraft. As an aircraft approaches it increases in apparent size, and the marine mammals react accordingly. Mitigation measures imposed on future exploration activities would be expected to minimize adverse effects to marine mammals and subsistence hunts in the Beaufort Sea Planning Area. Aircraft activities associated with the proposed action are anticipated to have a minor effect on marine mammal resources and harvests Beaufort Sea Planning Area.

4.4.2.12.1.3. Anticipated Effects From Discharges. Existing water quality of the OCS is relatively pristine due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs. Industrial impacts are minimal; with degradation of coastal water quality primarily confined almost exclusively to external intrusions, and naturally occurring processes. Existing pollution occurs at very low levels in arctic waters and/or sediments and do not pose an ecological risk to marine organisms in the OCS. The Clean Water Act prohibits anybody from discharging “pollutants” through a “point source” into a “water of the United States,” unless they have an NPDES permit. Industry is required to obtain such permits for its activities in the Arctic. The permit contains limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people’s health. The EPA issued the final Arctic General permit in June 2006.

In addition, “Management measures” are defined in Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) as economically achievable measures to control the addition of pollutants to coastal waters that reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint-pollution-control practices, technologies, processes, siting criteria, operating methods, or other alternatives. These management measures will be incorporated by owners/operators of OCS leases within any proposed postlease activities. These management measures would be reviewed by the applicable State and Federal agencies, as well as states within their coastal nonpoint programs that, under CZARA, are to provide for the implementation of management measures. See also effects from discharge discussions in Sections 4.4.1.12.1.3 and 4.4.1.12.4.3.

4.4.2.12.1.4. Anticipated Effects From Large Oil Spills. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect marine mammals important for the subsistence harvest and harvest practices. Exposure of important subsistence resources and harvest areas to oil spills is discussed in Sections 4.4.1.12.1.4.1 and 4.4.1.12.4.4. The same mitigation measures described in Section 4.4.1.3.12.2 would be implemented for the proposed lease sales. A large spill from a well blowout is described as a very unlikely event and no large oil spills are assumed to occur during exploration (Appendix A, Section 1.1.4).

It is important to remember that a large spill associated with OCS oil and gas activities would likely only occur during the production phase when volumes of oil or gas product is being moved to production facilities in the existing facilities at Kuparuk or Prudhoe Bay. Such a commercial discovery warranting production has not been identified or proposed for development. This section will describe how a large

spill could have major impacts on subsistence resources and practices even though a spill from production activities is not considered a reasonably foreseeable future event.

The MMS models large spills in order to estimate the percent chance that a large spill could contact important resources and then analyzes the potential effects from large oil spills to determine which areas have the highest chance of contact. In the following sections we evaluate the vulnerability of certain land segments and environmental resources areas, identified because of their traditional importance as harvest areas.

4.4.2.12.1.4.1. Oil-Spill Analysis. The potential for large spills to contact subsistence resources and harvest areas in the Beaufort Sea was previously described in the Beaufort Sea Multiple Sale FEIS and the Sale 195 and 202 EAs (USDOI, MMS 2003, 2005, and 2006). Due to small adjustments in the ERAs, changes in lease areas and other model refinements, we have updated the assessment for the proposed Beaufort Sea Lease Sales below.

No large oil spills are assumed to occur during exploration activities. For the development and production phase, a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline is assumed in this EIS. The chances of either spill contacting specific environmental resource areas would be the same. The 1,500-bbl spill would cover a smaller area (181 km²) than the 4,600-bbl spill (320 km²) after 30 days. Only the 4,600-bbl spill is discussed below, as it represents the highest range of potential contact and impact from a large oil spill. Approximately 40% of a 4,600-bbl spill during the summer open-water period would remain after 30 days, covering a discontinuous area of 320 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km². If a large spill occurs during the winter season, it is assumed that at least part of the spill would not be cleaned up prior to ice breakup and, thus, could contact one or more important habitat areas after ice breakup.

The following discussion presents conditional and combined probabilities (expressed as a percent chance) estimated by the OSRA model of a large spill contacting or occurring and contacting best known harvest areas important to subsistence resources and practices. Conditional probabilities are based on the assumption that a large spill has occurred (see Appendix A). Combined probabilities, on the other hand, factor in the chance of one or more large spills occurring and then contacting. The probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the environmental resource areas and land segments discussed. The resource area locations are found in Appendix A, Maps A.1-2a through 2e, and the launch areas and pipeline segments are found in Appendix A, Map A.1-4 (Beaufort Sea). An environmental resource area can represent an area important to one or several species or species groups during a discrete amount of time.

Conditional Probabilities. This section describes the conditional probabilities estimated by the OSRA model of a large oil spill in the Beaufort Sea contacting important subsistence environmental resource areas or land segments that are important to subsistence resources and the subsistence harvest. No large oil spills are assumed to occur during exploration activities. The OSRA model estimates conditional probabilities (expressed as a percent chance) of a spill contacting subsistence environmental resource areas or land segments. Unless otherwise noted, the conditional probabilities during summer or winter within 30 and 360 days are found in Tables A.2-65, 66, 71, 72, 77, 78, 83, 84, 113, 114, 119, 120, 125, 126, 131, and 132. The winter and summer discussed below are the time periods when a large spill could start.

A large spill could contact environmental resource areas where important subsistence resources are present. The following discussion presents conditional and combined probabilities estimated by the OSRA model (expressed as a percent chance) of a spill contacting or occurring and contacting subsistence-resource areas. Conditional probabilities are based on the assumption that a large spill has occurred and makes contact. Combined probabilities, on the other hand, factor in the chance of one or more large spills occurring and then contacting. Oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a spill could affect bird hunting, sealing, the walrus hunt, and whaling, as well as netting of fish in the ocean.

Summer - Point Hope, Point Lay, and Wainwright. The environmental resource areas for Point Hope, Point Lay, and Wainwright contain crucial harvest areas for whales, walrus, seals, caribou, fish, and waterfowl. The OSRA model estimates a <0.5% chance of a large spill starting at LAs 1-25 and PLs 1-17 contacting important Point Hope subsistence ERA38, Point Lay subsistence ERA39, and Barrow subsistence ERA41 (Subsistence Whaling Area 1) within 30 days and 360 days. For Wainwright subsistence ERA40, there is a <0.5-1% chance of contact from LAs 1-2 within 30 days and a 1-2% chance of contact from LAs 1-5 and LA21 within 360 days; there is a 1% chance of contact from PL1 within 30 days, and a 1% chance of contact from PLs 1-2 and PL8 within 360 days.

Important Point Hope subsistence LSs 62 (Atosik Lagoon), 63 (Akoviknak Lagoon/Cape Thompson), 64 (Ipiutak Lagoon/Point Hope), 65 (Cape Lisburne), 66 (Ayugatak Lagoon); Point Lay and Wainwright LSs 69 (Cape Beaufort/Omalik Lagoon), 70 (Kuchaurak Creek), 71 (Kukpowruk River/Naokok Pass), 72 (Kokolik River/Point Lay), 73 (Akunik Pass/Tungaich Point), 74 (Kasegaluk Lagoon/Utukok River), 75 (Icy Cape), 76 (Avak Inlet/Tunalik River); and Wainwright LSs 77 (Mitliktavik/Nokotlek Point), 78 (Kuk River/Sigeakruk Point), 79 (Wainwright/Wainwright Inlet), and 80 (Point Franklin/Peard Bay) have a <0.5% chance of contact from all land segments and pipeline segments within 30 days. The same is true for LSs 62-79 for 360 days; LS80 has a 1% chance of contact from LAs 1 and 4 and PL1 within 360 days.

Winter - Point Hope, Point Lay and Wainwright. The OSRA model estimates a <0.5% chance of a large oil spill starting at LAs 1-25 and PLs 1-17 contacting important Point Hope subsistence ERA38, Point Lay subsistence ERA39, and Wainwright subsistence ERA40 within 30 days; for Wainwright subsistence ERA40, there is a 1-2% chance of contact from LAs 1-5, 7, 9, 11, 13-14, 16, and 21-25; there also is a 1-2% chance of contact from PLs 1-6, 8, 12, and 15-17 within 360 days.

Important Point Hope subsistence LSs 62-80 (Atosik Lagoon-Kugrua Bay) have a <0.5% chance of contact from LAs 1-25 and PLs 1-17 within 30 days. The same is true for LSs 62-79 for 360 days; LS 80 has a 1% chance of contact from LA24.

Summer – Barrow. The environmental resource areas for Barrow contain crucial harvest areas for whales, walrus, seals, caribou, fish, and waterfowl. The OSRA model estimates a <0.5% chance of a large spill starting at LAs 1-25 and PLs 1-17 contacting important Barrow subsistence ERA41 (Subsistence Whaling Area 1) within both 30 days and 360 days. For Barrow subsistence ERA42 (Subsistence Whaling Area 2), the OSRA model estimates a 1-68% chance of contact from LAs 1-11, 21-22, and 24 within 30 days and a 1-69% chance of contact from LAs 1-16, 21-22, and 24 within 360 days. There is a 1-58% chance of contact from PLs 1-4, 8-11, and 15 within 30 days and a 1-61% chance of contact from PLs 1-6, 8-13, and 15-16 within 360 days.

Important Barrow subsistence LSs 81 (Peard Bay/Point Franklin), 82 (Skull Cliff), and 83 (Nulavik/Loran Radio Station) have a <0.5% chance of contact from LAs 1-25 and PLs 1-17 within 30 days and a 1% chance of contact from LAs 1, 3, and 1 and a <0.5-1% chance of contact from PLs 1 and 8 within 360 days. Barrow subsistence LSs 84 (Walakpa River/Will Rodgers and Wiley Post Memorial), 85

(Barrow/Elson Lagoon), 86 (Dease Inlet), 87 (Kurgorak Bay), 88 (Cape Simpson), 89 (Smith Bay), 90 (Drew Point/McLeod Point), 91 (Lonely/Pitt Point), and 92 (Cape Halkett) have a 1-18% chance of contact from LAs 1-13, and 21 within 30 days and a 1-19% chance of contact from LAs 1-25 (all launch areas) within 360 days. The OSRA model estimates a spill originating at PLs 1-5, 8-12, and 15, has a 1-19% chance of contact within 30 days and from PLs 1-17 (all pipeline segments) there is a 1-20% chance of contact within 360 days.

Winter – Barrow. The chance of spills contacting subsistence environmental resource areas tends to be less for spills starting in winter compared to summer. The OSRA model estimates a 1-4% chance of a large spill starting at LAs 1-5 and 21 contacting important Barrow subsistence ERA41 (Subsistence Whaling Area 1) within 30 days and a 1-5% chance of contact from LAs 1-7, 10, 21-22, and 24 within 360 days; there is a 1-3% chance of contact from PLs 1-2 and 8 within 30 days and a 1-4% chance of contact from PLs 1-3, 9, and 15-16 within 360 days. For Barrow subsistence ERA42 (Subsistence Whaling Area 2), the OSRA model estimates a 1-10% chance of contact from LAs 1-8 within 30 days during the winter and a 1-11% chance of contact from LAs 1-25 (all launch areas) within 360 days; there is a 1-7% chance of contact from PLs 1-3, 8-9, and 15 within 30 days and a 1-9% chance of contact from PLs 1-17 (all pipeline segments) within 360 days.

Important Barrow subsistence LSs 81-83, described above have a <0.5% chance of contact from all launch areas and all pipeline segments within 30 days and a 1% chance of contact from LAs 1-3, 7, 9, 21-22, and 24 and a 1-3% chance of contact from PLs 1-3, 5-6, 8, 10-13, and 15-16 for 360 days during winter. Barrow subsistence LSs 84-92 (Walakpa River-Cape Halkett) have a 1-3% chance of contact from LAs 1-8, 10, 12, and 14 within 30 days and a 1-14% chance of contact from all launch areas within 360 days. From a spill originating at PLs 1-6 and PLs 8-12, there is a 1-3% chance of contact within 30 days and from all pipeline segments, there is a 1-12% chance of contact within 360 days.

Summer – Nuiqsut. The environmental resource areas for Nuiqsut contain crucial harvest areas for whales, seals, caribou, fish, and waterfowl. The OSRA model estimates a 1-43% chance of a large spill starting at LAs 7-17, 19, and 22 contacting Nuiqsut subsistence ERA43 (Cross Island Subsistence Whaling Area) within 30 days and a 1-44% chance of contact from LAs 6-17, 19-20, and 22-23 within 360 days. There is a 1-34% chance of contact from PLs 2-7, 9-13, and 16-17 within 30 days and a 1-34% chance of contact in 360 days from 2-7, 9-14, and 16-17. Nuiqsut subsistence ERA97 (Tigvariak Island) has a <0.5% chance of contact from a large oil spill starting at all launch areas and all pipeline segments for both 30 and 360 days.

Nuiqsut subsistence LSs 92 (Cape Halkett), 93 (Atigarupoint/Harrison Bay), 94 (Fish Creek), 95 (Colville River/Colville River Delta), 96 (Kalubik Creek/Oliktok Point), 97 (Beechey Point/Bodfish, Cottle, and Jones Islands/Milne Point/Simpson Lagoon), 98 (Gwydyr Bay/Kuparuk River), 100 (Foggy Island Bay), and 101 (Bullen Point) have a 1-13% chance of contact from LAs 1-17, 19, and 21 within 30 days and a 1-15% chance of contact within 360 days from LAs 1-17, 19, and 21-25. From a spill originating at PLs 1-15 and 17, there is a 1-19% chance of contact within 30 days, and from all pipeline segments there is a 1-20% chance of contact within 360 days. Land segments from the Colville River Delta to Bullen Point-Tigvariak Island include areas historically used by Nuiqsut subsistence hunters to harvest caribou, waterfowl, marine fish, polar bears, and small furbearers. This is not an area of high subsistence use at the present time. More recently, hunting appears to take place nearer to the community and onshore areas of primary importance on the Colville River Delta.

Winter – Nuiqsut. The OSRA model estimates a 1-7% chance of a large oil spill starting at LAs 10-17 within 30 days or from LAs 10-20 within 360 days contacting important Nuiqsut subsistence ERA 43 (Cross Island Subsistence Whaling Area). There is a 1-5% chance of contact from PLs 5-7 and 11-13

within 30 days or PLs 5-7 and 11-14 within 360 days. Nuiqsut subsistence ERA97 (Tigvariak Island) has a <0.5% chance of contact from a large oil spill starting at all launch areas and pipeline segments for both 30 and 360 days.

Nuiqsut subsistence LSs 92-101 (Cape Halkett-Bullen Point) have a <0.5-3% chance of contact from LAs 6-8, 10, 12, and 15 within 30 days and a 1-13% chance of contact within 360 days from all launch areas. From a spill originating at PLs 2-4 and 9-13, there is a 1-3% chance of contact within 30 days and from all pipeline segments, there is a 1-11% chance of contact within 360 days.

Summer – Kaktovik. The environmental resource areas for Kaktovik contain crucial harvest areas for whales, seals, caribou, fish, and waterfowl. The OSRA model estimates a 1-26% chance of a large oil spill starting at LAs 10, 12-20, and 22-23 contacting important Kaktovik subsistence ERA44 (Subsistence Whaling Area) within 30 days and a 1-20% chance of contact from LAs 7-20 and 22-25 within 360 days. There is a 1-39% chance of contact from PLs 5-7, 10-14, and 17 within 30 days and a 1-43% chance of contact within 360 days from PLs 3-7, 9-14, and 16-17.

The LSs 103 (Brownlow Point/Canning River), 104 (Camden Bay/Collinson Point), 105 (Anderson Point/Sadlerochit River), 106 (Arey Island/Barter Island/Hulahula River), 107 (Kaktovik/Jago Lagoon), 108 (Griffin Point), 109 (Beaufort Lagoon), 110 (Icy Reef/Kongakut River), and 111 (Demarcation Point/Demarcation Bay) have a 1-18% chance from LAs 12, 14-20, and 23 within 30 days and a 1-19% chance of contact within 360 days from all launch areas. From a spill originating at PLs 6-7, 12-14, and 17, there is a 1-14% chance within 30 days and 1-15% from all pipeline segments within 360 days.

Winter – Kaktovik. The OSRA model estimates a 1-4% chance of a large spill starting at LAs 14-20 and 23 contacting important Kaktovik subsistence ERA44 (Subsistence Whaling Area) within 30 days and a 1-4% chance of contact from LAs 14-20 and 23 within 360 days. There is a 1-7% chance of contact from PLs 6-7, 13-14, and 17 within 30 and 360 days.

The LSs 103-111 (Brownlow Point -Demarcation Bay) have a 1-5% chance of contact from LAs 15-20 for 30 days and a 1-17% chance from LAs 4, 5, and 7-25 within 360 days. From a spill originating at PLs 6-7, 13-14, and 17, there is a 1-4% chance of contact within 30 days and from PLs 2-7 and 9-17, there is a 1-13% chance of contact within 360 days.

Summer - Canadian Subsistence Environmental Resource Areas. The environmental resource areas for the Canadian Inuit communities of Aklavik, Inuvik, and Tuktoyaktuk at the mouth of the Mackenzie River contain crucial harvest areas for whales, seals, caribou, fish, and waterfowl. The OSRA model estimates a <0.5% chance of a large oil spill starting at all launch areas and pipeline segments contacting important Canadian subsistence ERA60, King and Shingle Point, and ERA90, Gary and Kendall Islands, within 30 days and a 1-4% chance of contact from all launch areas, except 18, and all pipeline segments, except 14, within 360 days.

The LSs 118 (Sabine Point), 119 (Shingle Point), 120 (Trent and Shoalwater Bays), 121 (Shallow Bay/West Channel), 122 (no geographic feature described), 123 (Outer Shallow Bay/Olivier Islands), 124 (Middle Channel/Gary Island), 125 (Kendall Island), and 126 (North Point/Pullen Island) have a <0.5% chance of contact from all launch areas and pipeline segments within 30 days; LSs 118-126 have a 1-3% chance of contact from all launch areas and pipeline segments within 360 days.

Winter - Canadian Subsistence Environmental Resource Areas. The OSRA model estimates a <0.5% chance of a large oil spill starting at all launch areas and pipeline segments contacting important Canadian subsistence ERA60, King and Shingle Point, and ERA90, Gary and Kendall Islands within 30

days and a 1-5% chance of contact from all launch areas except 18 within 360 days; there is a 1-4% chance of contact from all pipeline segments, except 13, within 360 days.

The LSs 118-126 (Sabine Point-Pullen Island), described above, have a <0.5% chance of contact from all launch areas and pipeline segments within 30 days; LSs 118 -126 have a 1-2% chance of contact from LAs 1, 3, 5-14, 16, and 19-24 within 30 days and 1-2% chance of contact from PLs 1-7, 9-12, and 15-17 for 360 days.

Combined Probabilities. Combined probabilities are defined in Appendix A (Section 4.3). Combined probabilities differ from conditional probabilities, in that they do not assume that a large spill has occurred and consolidate nonuniform weighting of launch probabilities into one unit probability. The chance that one or more large spill would occur is multiplied by the areawide chance that a large spill would contact a particular environmental resource area to calculate a combined chance that both would occur.

Combined probabilities express the percent chance of one or more large spills occurring and contacting a certain environmental resource areas or land segments over the 20-year production life of the Beaufort Sea Sales 209 and 217. For combined probabilities, the OSRA model estimates a <0.5% chance that one or more large oil spills would occur and contact subsistence-specific ERAs 38 (Point Hope), 39 (Point Lay), 40 (Wainwright), 41 (Barrow Subsistence Whaling Area 1), 60 (King and Shingle Point, Canada), 90 (Gary and Kendall Islands, Canada), and 97 (Tigvariak Island) for both 30 and 360 days; the OSRA model estimates a 1% chance that one or more large oil spills would occur and contact subsistence-specific ERAs 42 (Barrow Subsistence Whaling Area 2), 43 (Nuiqsut Subsistence Whaling Area), and 44 (Kaktovik Subsistence Whaling Area) within 30 days and a 1-2% chance within 360 days over the 20-year production life of the proposed action.

The potential for bowhead whales to be contacted directly from a large oil spill from the Beaufort Sea lease sales is relatively small, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas is considerably greater. Onshore areas and terrestrial subsistence resources, in general, seem to have a lower potential for oil-spill contact.

General Effects to Subsistence Resources and Practices from Oil Spills. General effects from oil exploration and development could be expected from potential oil spills and tainting and the cleanup disturbance that could occur after such a spill event. An oil spill affecting any part of the migration route of the bowhead whale could taint a resource that is culturally pivotal to the subsistence lifestyle. Even if whales were available for the spring and fall hunts, tainting concerns could leave bowheads less desirable and alter or stop the subsistence hunt. Communities unaffected by a potential spill would share bowhead whale products with impacted villages, and the harvesting, sharing, and processing of other resources should continue. While the concern is most typically phrased in terms of the potential effects of oil spills on whales and whaling, it can be generalized to a concern for marine mammals and ocean resources in general. Marine mammals and fish typically comprise 60% of a coastal community's diet, and the ocean is frequently referred to in public testimony as "the Inupiat garden." Concerns about tainting would apply also to walrus, seals, polar bears, and caribou. In the event of a large oil spill, it could cause potential short-term but serious adverse effects to some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Oil-spill-cleanup activities could produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters.

Although a spill could originate within the Beaufort Sea Planning Area, its indirect impacts might be felt by communities remote from the sale area and far removed from the spill. Essentially, concerns about

subsistence harvests and subsistence food consumption would be shared by all Inupiat and Yup'ik Eskimo communities in the Chukchi and Bering seas adjacent to the migratory corridor used by whales and other migrating species. Tainting concerns in these communities about resources initially and secondarily oiled could seriously curtail traditional practices for harvesting, sharing, and processing important subsistence species because all communities would share concerns over the safety of subsistence foods in general and whale food products and the health of the whale stock, in particular.

All areas directly oiled, areas to some extent surrounding them, and areas used for staging and transportation corridors for spill response would not be used by subsistence hunters for some time following a spill. Oil contamination of beaches would have a profound impact on whaling because even if bowhead whales were not contaminated, Inupiat subsistence whalers would not be able to bring them ashore and butcher them on a contaminated shoreline. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the persistence of oil in the environment, the degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. Such oil-spill effects would be considered major.

Specific Effects on Subsistence Resources.

Bowhead Whales. In the event of a large oil spill, the chance of oil contacting whales is likely to be considerably less than the chance of oil contacting bowhead habitat. If a spill occurred and contacted bowhead habitat during the fall migration, it is likely that some whales would be contacted by oil. It is unknown what effects an oil spill would have on bowhead whales, but some conclusions can be drawn from studies that have looked at the effects of an oil spill on other types of whales. It is likely that some whales would experience temporary, nonlethal effects, including one or more of the following symptoms: (1) oiling of their skin, causing irritation; (2) inhaling hydrocarbon vapors; (3) ingesting oil-contaminated prey; (4) fouling of their baleen; (5) losing their food source; and (6) temporary displacement from some feeding areas.

Some whales could die as a result of contact with spilled oil. Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age and degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small. Whales exposed to spilled oil are likely to experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales or their feeding areas from an oil spill.

Barrow elder Thomas Brower, Sr., observed an oil spill from a U.S. Navy vessel in the Plover Islands east of Barrow in 1944 where about 25,000 gal were spilled. According to Brower: "for four years after that oil spill, the whales made a wide detour out to sea from these islands. Those Native families could no longer hunt whales during these years at that location" (Brower, as cited in NSB, Commission on History and Culture, 1980).

Although this spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, the event is remembered more importantly as a time of devastation and deprivation

by those who directly witnessed the effects of the spill or those who were told of the event by witnesses. Not only were whales absent for 4 years following the spill, but other resources were absent or occurred in reduced numbers. The people of Barrow who remember the spill consider it evidence that even a relatively small oil spill in a defined area can have lasting effects on subsistence resources and harvests.

Beluga and Gray Whales, Seals, and Polar Bears. The effects from activities associated with Beaufort Sea oil and gas exploration and development are estimated to include the loss due to an oil spill of small numbers of seals, walrus, polar bears, beluga and gray whales.

Thomas Brower, Sr. stated that:

In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area—the Plover Islands—became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear (Brower as cited in NSB, Commission on History and Culture, 1980).

Again, it should be noted that some species' recovery was seen after 4 years.

Caribou and Terrestrial Mammals. A possible oil spill (1,500 or 4,600 barrels) could cause the loss of a number of caribou, moose, muskoxen, grizzly bears, and arctic foxes based on their scattered distribution on the North Slope.

Coastline habitats from Dease Inlet, Cape Simpson east to the Atigaru Point-Kogru River area and coastline habitats in the Kaktovik area have the highest risks of spill contact. Some caribou from the Teshekpuk Lake, Western Arctic, Central Arctic, or Porcupine Caribou herds could contact oil in these areas, as they move into these areas to escape insects. Even in a severe situation, perhaps up to a few hundred animals from one of these herds could get oil on their coats and die from toxic hydrocarbon inhalation and absorption. This loss probably would be small for any of these caribou herds.

For the most part, the effect of onshore pipeline spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou, moose, and muskox range within pipeline corridors. For the most part, onshore oil spills would be very local in their effects and would not be expected to significantly contaminate or alter caribou, moose, and muskoxen habitat. For most spills, control and cleanup operations at the spill site would frighten these terrestrial mammals away from the spill and prevent the possibility of these animals grazing on oiled vegetation. For grizzly bear, if an oil spill contaminated beaches and tidal flats along the Beaufort Sea coast, where bears catch fish and find carrion in the summer and fall, some bears are likely to ingest contaminated food, which would result in the loss of a few bears. Small mammals and furbearers could be affected by spills from oiling or ingestion of contaminated forage or prey; impacts would be localized around the spill area and would not have population level impacts. In the event that a large oil spill occurred in the Beaufort Sea, it is expected to result in the loss of a few hundred caribou, and fewer individual muskoxen, grizzly bears, and arctic foxes.

Fish. Fuel and oil spills are not expected to have a measurable effect on freshwater and marine fish populations although some marine fish in the immediate area of an offshore spill or diesel fuel spill could

be lethally or sublethally affected, particularly if the spill occurred when marine fish were migrating and feeding nearshore in summer or in overwintering areas.

Birds. Losses from oil spills likely would include the loss of several thousand birds due to oil contamination, with population recovery expected within a few generations.

4.4.2.12.1.5. Anticipated Effects From Small Oil Spills. Small oil spills are defined as being <1,000 bbl. The average crude-oil spill size is 126 gal (3 bbl) for spills <500 bbl. An estimated 89 small crude oil spills would occur during the 20-year oil production period, an average of more than four per year. The average refined oil spill size is 29 gal (0.7 bbl) and an estimated 220 refined oil spills would occur during the 20-year oil production period, an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur during each of the 20 years of production.

Small oil spills are not modeled by the OSRA but could adversely affect subsistence resources and practices. Small spills occur offshore on drilling structures and onshore on gravel pads near pipeline tie-in locations. Because of the small size of these spills and their expected containment onsite, effects on subsistence resources likely would be negligible although this would depend on the context of the spill, the area covered by spilled product, and the amount of time the product was in the environment before cleanup efforts began.

Offshore small spills should have minimal effects on marine mammals, as onshore spills should have minimal effects on terrestrial mammals. Overall, accidental small oil spills periodically could affect subsistence resources. Small oil spills have the potential to impact subsistence-harvest resources and patterns indirectly, because subsistence users will reduce their harvests of a particular resource if they fear that the resource has been contaminated. An oil spill of any volume into a river system or lake could have effects on subsistence-fish harvests. Loss of some portion of the subsistence-fish harvest would negatively affect the majority of communities in the proposed action area. Subsistence users typically would allow some period of time for contaminated resources or areas to recover following exposure to oil, effectively reducing the total resource amount and the total harvest area acreage available to them for the subsistence harvest.

4.4.2.12.1.6. Anticipated Effects From Oil-Spill Response and Cleanup. Oil-spill impacts do not factor in the effectiveness of oil-spill-response activities; an OSRP would be required of any operator before any oil development or production activities. Oil-spill-response plans typically identify the resources at risk and refer to the appropriate response tactics. Identified spill-cleanup strategies potentially would reduce the amount of spilled oil in the environment and tend to mitigate spill-contamination effects. There has been little experience with under-ice or broken-ice oil spills, and local residents have little confidence in industry's current capability to successfully clean a spill of this type up in a timely manner (USDOJ, MMS, 2007c).

Disturbance to whales, walrus, seals, polar bears, caribou, fish, and birds would increase from oil-spill-cleanup activities. Offshore, skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup could cause whales to temporarily alter their swimming direction. Such displacement would cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they normally are harvested or to become more wary and difficult to harvest. People and boats offshore and people, support vehicles, and heavy equipment onshore, as well as the intentional hazing and capture of animals would disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Deflection of resources, resulting from the combination of a large oil spill and spill-response activities, would persist beyond the timeframe on a single season, perhaps lasting several years. The result would be a major effect on

subsistence harvests and subsistence users, who would suffer impacts on their nutritional and cultural well-being.

In the case of a winter spill, when few important subsistence resources would be present, cleanup is likely to be fairly effective in dealing with a spill before migrating whales and other species return to the area during breakup and the open-water season. Ringed seals are common during the winter, but they are not harvested by local subsistence hunters during this period. Subsistence hunting also would be impacted by any spill that required the local knowledge, the experience, and the vessels of local whaling captains. This diverting of effort and equipment to oil-spill cleanup would adversely impact the subsistence whale hunt, and oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season. Far from providing mitigation, oil-spill-cleanup activities more likely should be viewed as an additional impact, potentially causing displacement of the subsistence hunt, subsistence resources, and subsistence hunters (see Impact Assessment, Inc., 1998).

4.4.2.12.1.7. Anticipated Effects From Seismic Surveys. Seismic activities are used to locate and delineate potential oil and gas resources. Exploration and delineation drilling, seismic work, and related support activities are typically conducted from vessels during the ice-free, open-water period. The MMS will impose the mitigation measures described in Section 4.4.1.12.2 on future exploration and development activities to avoid or minimize adverse effects on subsistence resources and practices.

Up to three open-water seismic surveys (both 2D and 3D) could be conducted seasonally in the Beaufort Sea Planning Area during the open-water season. The Beaufort Sea season would begin in July and, depending on ice conditions, extend into late October. Ocean-bottom-cable surveys could occur in the shallower State waters of the Beaufort Sea. Three additional vessels (one of which could be used for ice management in emergency situations) would serve as support vessels for the three seismic-survey vessels. Helicopters also would be used for vessel support and crew changes. No estimates have been developed for the expected number of line miles of seismic survey to be done or the number of helicopter support flights that might be needed.

The greatest potential disruption of the subsistence whale hunt would be expected in the traditional bowhead whale-hunting areas for Kaktovik, Nuiqsut, and Barrow, where multiple seismic-survey operations could deflect whales away from traditional hunting areas. Conflict avoidance agreements (CAA) between the AEWC and oil operators conducting one or perhaps two seismic-survey operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities in the past, but the magnitude of three concurrent seismic surveys and the breakdown of the CAA process would test the ability of survey operators and whalers to coordinate their efforts to prevent disruptions to the hunt.

Barrow's fall bowhead whale hunt could be particularly vulnerable. Noise effects from multiple seismic surveys to the west in the Chukchi Sea and to the east in the Beaufort Sea potentially could cause migrating whales to deflect farther out to sea, forcing whalers to travel farther, increasing the effort and danger of the hunt and increasing the likelihood of whale-meat spoilage, as the whales would have to be towed from greater distances. Barrow's fall hunt is particularly important, as it is the time when the Barrow whaling effort can "make up" for any whales not taken by other Chukchi Sea and Beaufort Sea whaling communities. These communities give their remaining whale strikes to Barrow, hoping that Barrow whaling crews will successfully harvest a whale and then share the meat back with the donating community. This practice puts a greater emphasis on the Barrow fall hunt. Additionally, changing spring-lead conditions—ice becoming thinner in recent years due to arctic warming—have made the spring hunt more problematic and make the pivotal fall hunt even more vulnerable. Thus, any disruption of the Barrow bowhead whale harvest could have significant effects on regional subsistence resources and harvest practices (USDOI, MMS 1987b; Brower, 2005).

Barrow whaler Gordon Brower, stated in his comments on MMS' 2007-2012 Proposed 5-Year Leasing Program:

Barrow whalers and Nuiqsut whalers have encountered 'unacceptable levels' of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Inupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Inupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season's events. Our culture is surrounded by the whale. (Brower, 2005)

Even though the potential of up to three concurrent surveys being conducted in the open-water season in the Beaufort Sea is low, the additive and synergistic noise impacts produced by more than a single seismic survey would indicate an acoustic environment where clearly much more than a single sound event and a "low level" of activity is occurring; thus, the approach of considering seismic-survey noise as a short-term and local disturbance phenomenon to these species could be considered too simplistic.

Given the level of potential seismic-survey activity described in the scenario—up to three concurrent seismic surveys seasonally in the Beaufort Sea—and past assessments of species and resource effects discussed above, whales, pinnipeds, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing major impacts. Protective mitigation measures incorporated into seismic-survey permits, required industry Adaptive Management Mitigation Plans (AMMPs), and required mitigation under IHA requirements, as defined by NMFS and FWS is expected to reduce noise disturbance impacts (PEA), so that no unmitigable adverse effects to subsistence resources and harvest practices occur.

4.4.2.12.1.8. Anticipated Effects From Habitat Loss. Small amounts of temporary habitat loss could occur from drilling exploration or delineation wells into the seafloor. Permanent habitat loss would only arise from the construction of development and production facilities (an offshore platform, undersea pipeline, pipeline landfall to an onshore base, and onshore, a shore base/processing facility and a pipeline linking to existing infrastructure)—facilities not considered reasonably foreseeable at this time. Although recent innovations in the oil industry have reduced the size of an oil field footprint, habitat loss must continually be assessed and this information be used to keep track of effects to wildlife populations, subsistence resources, and subsistence harvests (Robertson, 1989). Alterations from offshore production platform/island construction, trench dredging, and pipeline burial would affect some benthic organisms and fish species near such activities. These activities also would temporarily affect the availability of some local food sources for some species during island construction, but are not expected to long-term food availability. Rapid habitat changes due to global climate change would serve to exacerbate anticipated habitat loss and habitat impacts.

4.4.2.12.1.9. Anticipated Effects From Onshore and Offshore Development. Coastal communities have infrastructure that includes airstrips, landfills, and a variety of buildings and dwellings. The MMS assumes that the same trends associated with the maintenance and development of coastal communities will continue. One example of such activity is a proposed airport construction project at Barter Island. Individual fields have been developed to share common wells, production pads, and pipelines. Over time, fields have been grouped into production units with common infrastructure, such as processing facilities. The MMS assumes that these same types of activities needed to support existing oil and gas infrastructure would continue into the future. The construction of gravel roads, pads, and the

excavation of gravel mines are examples of the types of activities associated with development and maintenance of oil and gas activities on the North Slope. The MMS assumes these activities will continue to occur.

See Table 3.1.1-1 for North Slope oil discoveries and a “best guess” approximation for their potential production. Twenty-three discoveries are listed that might have development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 20 years, including several offshore fields in the Beaufort Sea (Liberty, Sandpiper, Kuvlum, Thetis Island, Flaxman Island, Stinson, Nikaitchuq, Tuvaq, and Hammerhead). Some of the pools located offshore are developed from onshore sites and therefore are listed as onshore fields. Sandpiper, Liberty, Hammerhead, and Kuvlum are on offshore Federal leases; all others are on State leases or NSB lands. There are no discoveries in the Chukchi Sea Planning Area that are anticipated to be developed within the next 20 years. A large-scale gas transportation system from the North Slope will not be operational for at least a decade. Excess capacity in this system will not be available for another decade after that. When there is capacity in the system, new gas developments are likely to be prioritized according to accessibility and cost. Such a pipeline is considered by MMS to be speculative at this time.

Under our proposed scenario, primary development activities would occur from exploration driven seismic surveys that would take place in the summer, open-water months between June and November. Construction of offshore production and transportation facilities could be carried out during the summer months and completed in 1-2 years. Construction of onshore support and transportation facilities could be carried out during the summer and winter months simultaneously with offshore work. Once construction is complete, production facility operations would occur year-round, over a 25-year period. The analyses in Section 4.4.1.12.1 describe and evaluates the potential effects of noise (seismic and drilling activities), habitat alterations (construction of platforms and pipelines), and discharges effects.

Overall, potential disturbance effects from production operations may be more difficult to mitigate, as such activities will by definition be longer term and operate year-round. The need to install up to 4-13 production platforms, drill 160-400 production wells, construct 90-550 mi of offshore pipeline, up to 500 mi of onshore pipeline, and construct three pipeline landfalls, and two new shore bases in the region could increase the areas and times where subsistence resources and activities are restricted. This would increase the possibility for significant harvest disruption. This would be further exacerbated if construction and production activities were concentrated in critical subsistence-use areas rather than dispersed. Offshore pipeline effects on subsistence generally would be confined to the period of construction, and would be mitigated through lease stipulations, which would minimize industry activities during critical subsistence-use periods.

The potential impact of an onshore pipeline on subsistence-resource-use patterns, while unavoidable, can be mitigated at least partially and minimized with proper pipeline design and location/routing. Potential effects of a pipeline on subsistence users (perceptions of areas they wish to avoid, or which are difficult for them to access, for hunting) can be addressed with design considerations (for instance, by elevating or burying segments of the pipeline) and by including subsistence users in the consultation process. The most difficult potential onshore pipeline effects to mitigate would be those related to pipeline servicing and access. Service roads constructed for this purpose, would greatly increase impacts to caribou movement and access to subsistence resources on the western part of the North Slope. This effect would be greater if such a road were eventually opened to public access, on the model of the Dalton Highway. Roads are also reported to impose substantial maintenance costs on subsistence equipment (snow machines and sleds) and to present some safety issues (Impact Assessment, Inc., 1990a). Current practices are to minimize the construction of new roads. If pipeline servicing was conducted using aircraft, and perhaps ice roads or other ground transport in winter, such potential access effects would be

minimized. Increased aircraft traffic in the summer could have a moderate effect on subsistence uses, but with coordination with subsistence users such impacts could be reduced.

Negative impacts to caribou can be minimized by mitigation measures, including: (1) construction of pipelines at least 100 m from roads; (2) elevation of the pipelines above the ground to ensure that caribou can pass underneath; (3) maintenance of traffic control in critical areas such as calving grounds, in season; (4) installation of buried or higher than normal pipelines in areas that are typically heavily traveled by caribou; and (5) adherence to minimum altitude levels for service aircraft in flight.

Onshore construction would affect local availability of key subsistence resources (caribou, waterfowl, fish, wolves, wolverine, and seals) because of displacement and would occur in seasonal and general use-areas for key subsistence resources. Subsistence access would be affected as subsistence users avoid construction areas because of perceived regulatory barriers and safety concerns about shooting around industrial development. Subsistence hunters consequently would travel farther and at greater cost and effort. Key resources are harvested during more than one season each year; they have been used for multiple generations, and the affected areas are used for multiple resources each year. Effects from construction would occur in key geographic areas relative to other areas of subsistence availability and would pertain to individual subsistence users, groups of users, and the overall pattern of local subsistence uses (USDOJ, BLM, 2004).

4.4.2.12.1.10. Anticipated Effects from Production Activities. For purposes of analysis, we assume that development activities could occur in the reasonable foreseeable future. Reserve estimates for Northstar, Ooguruk, Nikiatchuq, and the Duck Island Unit are included in our estimates for offshore developments as well as any known discoveries in the Beaufort and Chukchi seas such as Hammerhead and Kuvlum.

There is also no accurate way to predict future gas development activities outside of the core area of the North Slope where most of the proven gas resources are located. With the exception of Point Thomson, the majority of future gas production during the first 10-15 years of gas pipeline operation will be the gas that has been previously cycled through existing oil-production infrastructure. Thus, any environmental impacts of gas production in the period of 2015-2030 largely would be an extension of current operations. The largest gas accumulation on the North Slope is in the Prudhoe Bay field. These proven resources are uneconomic to produce, because there is no gas-transportation system to market. Various plans have been studied to bring North Slope gas to market, but no plan has overcome the high project cost and marketing hurdles. At present, the most likely transportation system is a large-diameter gas pipeline to markets outside of Alaska. Such a pipeline is considered by MMS to be speculative at this time. See Section 4.4.2.12.1.9, Anticipated Effects from Onshore and Offshore Development, for a description of anticipated effects.

4.4.2.12.1.11. Anticipated Effects From Climate Change. Sections 4.4.1.12.1.9 and 4.4.1.12.4.11 described the potential and anticipated effects from climate change on subsistence resources and practices.

Continuing sea ice melting and permafrost thawing will threaten subsistence livelihoods. Typically, Arctic peoples have settled in particular locations because of their proximity to important subsistence food resources and dependable sources of water, shelter, and fuel. Northern peoples and subsistence practices will be stressed to the extent: (1) settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise; (2) traditional hunting locations are altered; (3) subsistence travel and access difficulties increase; and (4) as game patterns shift and their seasonal availability changes. Large changes or displacements of resources are likely, leaving little option for subsistence communities: they must

quickly adapt or move (Langdon, 1995; Callaway, 1995; *NewScientist* 2001; Parson et al., 2001; AMAP, 1997, *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001b). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird-breeding and -molting areas, affect the distribution and abundance of anadromous and freshwater fish, and limit or alter subsistence access routes (particularly in spring and fall) (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal-migration routes, and this, in turn, would impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001).

Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet would be expected (IPCC, 2001b; NRC, 2003b; ACAI, 2004).

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses if warming trends continue (NRC 2003b, ACAI 2004). Every community in the Arctic is potentially affected by the anticipated climactic shift and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of coastal communities in the Beaufort Sea. If the loss of permafrost and conditions beneficial to the maintenance of permafrost arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of freshwater, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC 2003b, ACAI 2004; USDOI, BLM, 2005; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; United Nations Environment Programme, 2005; Callaway, 2007).

4.4.2.12.2. Direct and Indirect Effects Under Alternative 2.

Summary. The following analysis describes only the anticipated effects on subsistence resources and harvests that would most likely occur if the MMS opens the entire lease sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.12.2 and 4.4.1.12.4.1. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on subsistence resources and harvests if such a discovery is made and proposed for development in the more distant future.

Direct effects include delay or deflection of resource populations' movements and mortality; indirect effects include destruction or degradation of habitat and changes in productivity. The placement of a drilling structure or production island near the bowhead whale migration corridor that operated over the life of a field (15-20 years) would represent a major effect because of potential long-term noise disturbance to migrating whales. Potential disturbance from seismic surveys in the central Beaufort Sea conducted during the open-water season likely would cause bowhead whales to experience temporary,

nonlethal effects. Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, although most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects. Similar impacts would be expected on beluga whales, walruses, seals, and polar bears.

Onshore effects under Alternative 2 from oil exploration and development on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 0.62-1.2 mi along onshore pipelines, with local effects persisting during construction activities. Brief disturbances of groups of caribou and muskoxen from a few minutes to a few days could occur along pipeline corridors during periods of high ice-road and air traffic, but these disturbances are not expected to affect the movements and distribution of caribou, muskoxen, grizzly bears, and arctic foxes.

Given the level of potential seismic-survey activity described in the scenario—up to three concurrent seismic surveys seasonally in the Beaufort Sea—and past assessments of species and resource effects discussed above, whales, pinnipeds, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing major impacts. Protective mitigation measures incorporated into seismic-survey permits, required industry Adaptive Management Mitigation Plans (AMMPs), and required mitigation under IHA requirements, as defined by NMFS and FWS is expected to reduce noise disturbance impacts (USDOJ, MMS, 2006a), so that no unmitigable adverse effects to subsistence resources and harvest practices occur.

A recent breakdown in the CAA process has precipitated the need for industry to develop an annual AMMP that contains similar measures as contained in past CAAs to avoid whaling and other subsistence-harvest conflicts. Similar avoidance measures in the AMMP could be required for the subsistence hunts for beluga whales, walrus, seals, and polar bears. The AMMP is expected to follow protocols similar to those reached annually between permittees and the AEWG for the subsistence bowhead hunt and address industry seismic-vessel activities under provisions of the MMPA. With the use of an annual AMMP, it is expected that Native subsistence-whale hunters will continue to be successful in their marine mammal harvests and in reaching their annual whale “take” quotas. Without an AMMP in place, major impacts to the subsistence resources and hunts for bowhead and beluga whales, walrus, bearded seals, and polar bears would result.

A large oil spill could affect subsistence resources and communities of Kaktovik, Nuiqsut, and Barrow. In the event of a large oil spill, many harvest areas and some subsistence resources could become unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads and threaten a pivotal element of Inupiat culture. There also is concern that the IWC, which sets the quota for the Inupiat subsistence harvest of bowhead whales, would reduce the harvest quota following a major oil spill or, as a precaution, as the migration corridor becomes increasingly developed to ensure that overall population mortality did not increase. Such a move would have a profound cultural and nutritional impact on Inupiat whaling communities. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree these resources were contaminated. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters. Overall, such effects are not expected from routine activities and operations. Tainting concerns also would apply to polar bears, seals, beluga whales, walruses, fish, and birds.

Conclusion. Disturbance and noise could affect subsistence species that include bowhead and beluga whales, walruses, seals, polar bears, caribou, fish, and birds. For the communities of Kaktovik, Nuiqsut, and Barrow disturbances periodically could affect these subsistence resources, but no resource or harvest

area would become unavailable and no resource population would experience an overall decrease. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt.

Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would be expected to avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on subsistence resources and subsistence-harvest patterns, producing major effects.

4.4.2.12.3. Cumulative Effects Under Alternative 2.

Summary. Anticipated effects under the Proposed Action are combined with the anticipated effects under the no-action alternative (see Section 4.4.1.12.7) to determine the cumulative effects for this alternative. The noise-producing exploration and construction activities are those most likely to produce disturbance effects on critical subsistence species that include bowhead and beluga whales, caribou, fish, seals, and birds. Disturbance effects would be associated with aircraft and vessel noise, construction activities, and oil spills; specifically: (1) seismic surveys that occur prior to an oil and gas lease sale; (2) aircraft support of exploration and development activities; (3) possible vessel supply and support of exploration and development activities; (4) drilling activities during the exploration and development and production phases; and (5) onshore construction, including pipeline, road, support-base, landfall, and pump-station construction. Noise and traffic disturbance would be a factor throughout the life of the sale.

Seismic surveys and exploration drilling could continue at existing levels due to a limited number of suitable or specialized vessels for conducting these activities. No more than two drill rigs could operate in the Beaufort Sea at any one time. Similarly, no more than six seismic-surveying activities could be completed during a season, an unrealistic number because six seismic surveying vessels are not available. It is more reasonable to assume that no more than three seismic surveys could be completed simultaneously in the Beaufort Sea. Further impacts to subsistence resources and harvests would come from (1) ongoing maintenance and development projects in local communities; (2) onshore oil and gas infrastructure development; (3) passenger, research, and industry-support aircraft activities; (4) local boat traffic, barge resupply to local communities, research vessel traffic, industry-support vessel activities (mostly in support of seismic surveys), an increasing U.S. Coast Guard presence, and vessel traffic from increasing Arctic ecotourism. Ongoing actions include: (1) development and production activities at Endicott, Northstar, Badami, and Alpine; (2) recent leasing from Beaufort Lease Sales 195 and 202; (3) State leasing; and (4) onshore leasing activity in the NPR-A. Effects from these sources would continue to have a moderate level of effect on subsistence resources and harvest practices. The greatest source of large noncrude oil spills would occur from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and other shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on subsistence resources and harvest practices in the Beaufort Sea region.

Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development reduces the availability of resources or alters their distribution patterns. Cumulative effects to bowhead whales and other marine mammals is a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas and the traditional bowhead whale harvest could be adversely

affected. The same could be true for beluga whales, walrus and seals (USDOJ, MMS, 2003a). The disruption of bowhead whale harvests could result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals, making them more skittish, for example, in reaction to OCS activities. The greater the degree of activity onshore and oil and gas development in Federal, State, and Canadian waters, as measured by increases in seismic noise, vessel traffic, east-to-west development, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. If the IWC considers the threat of industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope as well as to Iñupiat in other communities who receive whale meat from the harvest (USDOJ, MMS, 2006b, 2007d; USDOJ, BLM and MMS, 1998).

Onshore development has already caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from nonsubsistence hunters for fish and wildlife (Haynes and Pedersen 1989). Additive impacts that could affect subsistence resources include potential oil spills, seismic noise, road and air traffic disturbance, and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas further from the local subsistence communities would require increased effort, risk, and cost on the part of subsistence users. Increasing onshore areas open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence harvest efforts in the undeveloped areas, and increasing the potential for conflict over harvest areas within a community (USDOJ, BLM, 2005). Based on potential cumulative, long-term displacement and/or functional loss, habitat available for caribou may be reduced or unavailable or undesirable for use. Changes in caribou population distribution due to the presence of oilfield facilities or activities may affect availability for subsistence harvest in traditional subsistence use areas. Overall, subsistence users likely would continue to travel farther to harvest resources, but hunters are unlikely to cease subsistence harvests given the pivotal value of subsistence activities and subsistence food. The communities of Nuiqsut, Barrow, and Atkasuk would be most affected by ongoing onshore activities. Changes in oil and gas exploration and development technology could mitigate some of the effects observed in the past (USDOJ, MMS, 2003a; USDOJ, BLM, 2004, 2005).

If a large oil spill occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season even though whales still would be available. In fact, even if whales were available for the spring and fall seasons, traditional cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest in Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope, and the beluga whale hunt in Point Lay for up to two seasons. Concerns over the safety of subsistence foods could persist for many years past any actual harvest disruption. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters. Such a condition would constitute a major adverse effect. Tainting concerns would also extend to walruses, seals, polar bears, fish, and birds; some or all of these resources could also suffer losses from an oil spill. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads, threatening a critical underpinning of Inupiat culture. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale and other marine mammal products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated.

Additionally, all areas directly oiled, areas to some extent surrounding them, and areas used for staging and transportation corridors for spill response would not be used by subsistence hunters for some time following a spill. Oil contamination of beaches would have a profound impact on whaling because even if bowhead whales were not contaminated, Inupiat subsistence whalers would not be able to bring them ashore and butcher them on a contaminated shoreline. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the persistence of oil in the environment, the degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. Such oil-spill effects would be considered major. Overall, such effects are not expected from routine activities and operations.

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet could be expected. Increasing climate change impacts are likely to produce major effects on subsistence activities by causing additional losses of traditional subsistence harvest areas and making traditional subsistence resources no longer available for harvest. Subsistence users would continue to travel farther to harvest resources, but are unlikely to cease subsistence harvests given the strong cultural continuity and value of subsistence activities (Johannessen, Shalina, and Miles, 1999; IPCC, 2001b; NRC, 2003a; NMFS, 2008b; USDO, BLM, 2005).

Conclusion. An increasing level of seismic-survey and drillship activity in the Beaufort Sea could displace whales, walrus, seals, and polar bears and alter their availability for an entire harvest season, causing major impacts to these subsistence resources and harvest practices that depend on them. Adaptive management mitigation to replace the mechanism of the conflict avoidance agreement has been incorporated in this draft EIS in order to reduce effects to subsistence sea mammals resources below a major level. Without such proposed mitigation in place, cumulative effects on subsistence resources and harvests from noise and disturbance would be major. To a large extent, existing stipulations and required mitigation have in the past mitigated such potential effects and may continue to do so. With an MMS approved industry AMMP in place, effects would be reduced to moderate. Additionally, stipulated measures for seismic-survey permits and mitigation accompanying NMFS IHA plans generally ensure that acceptable levels of whale monitoring will occur. Together, these measures should ensure that no unmitigable adverse effects to subsistence-harvest patterns, resources, or practices will occur. Cumulative impacts from a large oil spill, when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together would be considered major. If present rates of climate change continue, impacts to subsistence resources and harvests would be expected to be major.

4.4.2.13. Sociocultural Systems.

Summary. The following analysis describes only the anticipated effects on sociocultural systems that most likely would occur if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.13.2 and 4.4.1.13.4. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on sociocultural systems if such a discovery is made and proposed for development in the more distant future.

Disturbance and noise effects to subsistence species could include bowhead and beluga whales, walrus, seals, polar bears, caribou, fish, and birds. For the communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change are expected to exacerbate overall potential effects on subsistence resources and subsistence-harvest patterns, producing major effects.

4.4.2.13.1. Anticipated Effects to Sociocultural Systems. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects described in Section 4.4.13.1-8 and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.13.7. This section describes the impact on sociocultural systems resulting from the incremental impact of this action, Alternative 2 Proposed Action, and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency undertakes such actions. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures are described in Section 4.4.1.13.2. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices.

4.4.2.13.1.1. Anticipated Effects From Disturbance. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from vessel and aircraft disturbance described in Section 4.4.1.13.1.1, the same anticipated effects described in Section 4.4.1.13.4.1, and the same cumulative past, present, and reasonably foreseeable actions previously described in Section 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.2. Anticipated Effects From Discharges. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same anticipated effects from discharges described in Section 4.4.1.13.4.2 and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.13.7 for the Beaufort Sea no-action alternative.

4.4.2.13.1.3. Anticipated Effects From Large Oil Spills. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from large oil spills described in Section 4.4.1.13.3.1.2; the anticipated effects described in Section 4.4.1.13.4.3; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.13.7 for the Beaufort Sea no-action alternative. The potential for large oil spills to contact subsistence resources and harvest areas in the Beaufort Sea Planning Area was discussed in the oil-spill analysis Section 4.4.2.12.1.4 for the Subsistence-Harvest Patterns. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect marine mammals important for the subsistence harvest and harvest practices. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices. The same mitigation measures described in Section 4.4.1.12.2 would be implemented for the proposed lease sales. A large

spill from a well blowout is described as a very unlikely event, and no large oil spills are assumed to occur during exploration (Appendix A, Section 1.1.4).

The sociocultural impacts of oil spills are of at least two types. The first is the result of direct effects to resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life). The second is the impact of spill-cleanup efforts, in terms of short-term increases in population and economic opportunities, as well as increased demand on community services and increased stress to local communities. As is evident from the EVOS, such cleanup efforts can be quite disruptive socially, psychologically, and economically for an extended period of time. While the magnitude of impacts decline rapidly in the first year or two after a large spill, long-term effects continue to be evident (Palinkas et al., 1993; Picou et al., 1992; Picou and Gill, 1996). Such effects can be mitigated, and one important element in such a program is the establishment of, and local participation in, an effective spill-response effort that has been formulated into an explicit spill-response plan. Such local programs can be credited as one effect of spill events, and do have a number of benefits. They provide local employment, a sense of local empowerment, and a means for local resident/oil industry communication (USDOJ, MMS < 2007c).

4.4.2.13.1.4. Anticipated Effects From Small Oil Spills. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same anticipated effects from small oil spills described in Section 4.4.1.13.4.4 and the same cumulative past, present, and reasonably foreseeable actions described in Sections 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects of small oil spills on subsistence resources and harvest areas in the Beaufort Sea Planning Area were discussed in the Section 4.4.2.12.1.5 for the Subsistence-Harvest Patterns Alternative 2. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.5. Anticipated Effects From Oil-Spill Response and Cleanup. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from oil-spill response and cleanup described in Section 4.4.1.13.1.3, the same anticipated effects previously described in Section 4.4.1.13.4.5, and the same cumulative past, present, and reasonably foreseeable actions previously described in Section 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects of oil-spill response and cleanup to subsistence resources and harvest areas in the Beaufort Sea Planning Area were discussed in Section 4.4.2.12.1.6 for the Subsistence-Harvest Patterns Alternative 2. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.6. Anticipated Effects From Seismic Surveys. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from seismic surveys described in Section 4.4.1.13.1.4, the same anticipated effects previously described in Section 4.4.1.13.4.6, and the same cumulative past, present and reasonably foreseeable actions previously described in Sections 4.4.1.13.7 for the Beaufort Sea No no-action alternative. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.7. Anticipated Effects From Habitat Loss. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from habitat loss described in Section 4.4.1.13.1.5; the same anticipated effects previously described in Sections 4.4.1.13.4.7; and the same cumulative past,

present and reasonably foreseeable actions previously described in Sections 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.8. Anticipated Effects From Onshore and Offshore Development. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from onshore and offshore development described in Section 4.4.1.13.1.6; the same anticipated effects described in Section 4.4.1.13.4.8; and the same cumulative past, present, and reasonably foreseeable actions described in Sections 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.9. Anticipated Effects From Production Activities. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from production activity described in Section 4.4.1.13.1.7; the same anticipated effects described in Section 4.4.1.13.4.9; and the same cumulative past, present and reasonably foreseeable actions described in Sections 4.4.1.13.7 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

4.4.2.13.1.10. Anticipated Effects From Climate Change. Sociocultural systems in the Beaufort Sea Planning Area are subject to the same potential effects from climate change described in Section 4.4.1.13.1.8; the same anticipated effects previously described in Sections 4.4.1.13.4.10; and the same cumulative past, present and reasonably foreseeable actions described in Section 4.4.1.13.7 for the Beaufort Sea no-action alternative. Sections 4.4.1.12.1.9 and 4.4.1.12.4.11 for Subsistence-Harvest Patterns. Alternative 1 described the potential and anticipated effects from climate change on subsistence resources and practices. Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices in the Beaufort Sea coastal communities of Kaktovik, Nuiqsut, Atqasuk, and Barrow, previously described in the subsistence-harvest patterns discussion.

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses if warming trends continue (NRC 2003b, ACIA 2004). Every community in the Arctic potentially would be affected by the anticipated climactic shift, and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of coastal communities in the Beaufort Sea. If the loss of permafrost and conditions beneficial to the maintenance of permafrost arise as predicted, there could be synergistic cumulative effects on infrastructure; travel; land forms; sea ice; river navigability; habitat; availability of freshwater; and availability of terrestrial mammals, marine mammals, waterfowl, and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC 2003b, ACIA 2004; USDOJ, BLM, 2005; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; United Nations Environment Programme, 2005; Callaway, 2007).

4.4.2.13.2. Direct and Indirect Effects Under Alternative 2.

Summary. The following analysis describes only the anticipated effects on sociocultural systems that most likely would occur if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.13.2 and 4.4.1.13.4. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on sociocultural systems if such a discovery is made and proposed for development in the more distant future.

Disturbance and noise effects to subsistence species could include bowhead and beluga whales, walrus, seals, polar bears, caribou, fish, and birds. For the communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change are expected to exacerbate overall potential effects on subsistence resources and subsistence-harvest patterns, producing major effects.

Anticipated effects would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk could come from disturbance from oil exploration and development activities and from changes in population, employment, and subsistence-harvest patterns. Accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion), social organization, or sociocultural systems (USDOI, BLM and MMS, 2003; USDOI, MMS, 2006b).

Conclusion. Effects from anticipated 3D seismic surveys and exploration should not exceed moderate effects levels. For 3D and 2D seismic surveys and exploration, which are projected to occur for at least 3 years, effects to sociocultural systems are expected to be moderate. Effects to social well-being (social systems) could be noticeable because of concern over deflection of the bowhead whale due to seismic-survey activities and the attendant effects on subsistence harvests. These concerns may translate into greater activity as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If deflection actually occurred, effects could be major.

For routine activities from exploration, development and production, and decommissioning (abandonment), effects to sociocultural systems would cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level—a moderate level of effect.

For large oil spills, noticeable disruption in excess of 2 years could occur from the oil spill and cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns. Effects from a large oil spill would be expected to be major. Mitigation measures should prove effective in ameliorating many of the effects of OCS activities.

4.4.2.13.3. Cumulative Effects Under Alternative 2.

Effects from the contribution of future and other activities effects to subsistence resources and practices were discussed in Sections 4.4.1.12.7, and the same activities would be expected to impact sociocultural systems to the extent they adversely impacted subsistence resources and harvest practices.

Summary. Anticipated effects under the Proposed Action (Alternative 2) are combined with the anticipated effects under the no-action alternative (Alternative 1) to determine the cumulative effects for this alternative. The noise-producing exploration and construction activities are those most likely to produce disturbance effects on critical subsistence species that include bowhead and beluga whales, caribou, fish, seals, and birds. Disturbance effects would be associated with aircraft and vessel noise, construction activities, and oil spills; specifically: (1) seismic surveys that occur prior to an oil and gas lease sale; (2) aircraft support of exploration and development activities; (3) possible vessel supply and support of exploration and development activities; (4) drilling activities during the exploration and development and production phases; and (5) onshore construction, including pipeline, road, support-base, landfall, and pump-station construction. Noise and traffic disturbance would be a factor throughout the life of the sale.

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from oil exploration and development activities, oil spills and oil-spill cleanup, changes in population and employment, and subsistence-harvest patterns; accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion), social organization, or sociocultural systems but community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales from an oil spill (USDOI, BLM and MMS, 2003; USDOI, MMS, 2006b).

Offshore exploration and development in the Beaufort Sea is expected to increase, with lease sales planned for the near future by MMS and the State of Alaska in this offshore area. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk might result from seismic-exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of people and equipment for seismic exploration. However, the possible long-term deflection of whale migratory routes or increased skittishness of whales due to seismic-survey activities in the Beaufort Sea might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude proposed has not been approached in the region since the 1980s (USDOI, MMS, 2006a; USDOI, BLM, 2005).

While it is unknown exactly how much of the offshore area will be leased in these future sales, several ship-based exploratory seismic operations have been conducted during the open-water season in 2006 and

2007, resulting in conflicts with marine mammal hunters and concerns over the fall whaling harvest. Should offshore activity lead to a considerable decrease in success in fall whaling, it would contribute to major negative effects to the North Slope Iñupiat peoples' identity and could have culturewide effects (USDOI, BLM and MMS, 1998).

Onshore, continuing oil and gas leasing and development, as well as on-going changes in the arctic climate, will have impacts on Iñupiat sociocultural systems in the foreseeable future. Development is being considered for the Northeast NPR-A, the planning area for Alpine Field Satellites development, and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development. This problem could be exacerbated if gas development caused development to extend into the foothills of the Brooks Range. Cumulative effects could include changes to social organization and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization potentially could occur as a result of changes in population, employment, subsistence-harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities potentially could result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities (USDOI, BLM, 2005).

Overall, cumulative impacts to the sociocultural characteristics of North Slope communities could lead to changes to community structure, cultural values, and community health and welfare, changes that actually predate oil and gas development on the North Slope. However, change in community sociocultural characteristics has continued during the period of oil development. As the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atqasuk are currently dependent on subsistence caribou harvest from the CAH and TCH; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns (including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources), social bonds, and cultural values (USDOI, BLM, 2004; USDOI, MMS, 2006b).

Onshore, the abandonment of oil fields and the related loss of revenue would no doubt have serious effects on the entire State of Alaska. However, the collapse of commercial enterprise is seen as inevitable and is common over the history of the Iñupiat. Commercial whaling served the same markets as petrochemicals do today, and the Iñupiat survived by returning to the land. Fur trapping collapsed and the Iñupiat people adapted. Based on this historic demonstration of their resiliency, it would appear that the Iñupiat may be at less risk from the decline of industry than they are in the face of an expanding and unchecked industry. Nevertheless, worldwide data suggest a consistent pattern of marked increases in stress, social problems, and emigration under circumstances of sudden or severe economic depression. Data from Iñupiat populations has shown that economic depression correlates strongly with epidemic rates of suicide (Travis, 1984). In the event of oil field abandonment, the Iñupiat would likely be employed to assist in the removal and demobilization of the infrastructure, while at the same time continuing their subsistence pursuits (USDOI, BLM, 2005).

Additionally, areas of importance to subsistence users, including areas surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, could be impacted by oil and gas activities and could increase anxiety in Nuiqsut, Barrow, and Atqasuk (USDOI, BLM, 2005).

We may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The NSB already is experiencing problems

in the social health and well-being of its communities, and additional development, including offshore oil development on the North Slope, would further disrupt them. Health and social-services' programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and NSB city governments cannot help as much now that they get less money from the State. Based on experiences after the EVOS, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs (USDOJ, MMS, 2006b).

Not all sociocultural changes are negative. It is anticipated that there will be a doubling of the population on the North Slope by the year 2040. As long as core Iñupiat values continue to be passed from generation to generation, as they currently are, an increase in the Iñupiat population results in a strengthening of the culture as a whole. At the same time, revenues from NSB taxation on oil development produce positive impacts come from higher incomes, better health care, improved housing, and improved infrastructure and educational facilities, although these impacts may benefit primarily younger individuals who are generally more accepting of change (NRC, 2003a). Iñupiat culture as an adaptive mechanism is a powerful means of self-directed social, political, and cultural change capable of sustaining the Iñupiat through adverse circumstances, as it has for centuries guided them through resource shortages, inter- and intragroup social conflicts, and environmental changes (USDOJ, BLM, 2005).

Health issues caused by persistent and short-term pollution could shorten life spans of elders, who are the key repositories of traditional and cultural knowledge in the communities. Health issues from increased injuries as a result of the need to travel further over rough terrain to support families with subsistence foods could reduce community involvement with employment, tax the community health infrastructure, encourage outmigration, and lead to increases in substance abuse and depression in those no longer able to participate in subsistence activities. Cuts in funding for services would increase the severity of the problem of delivery of health services, as well as maintaining health and hygiene infrastructure (e.g., fresh water, sewers, and washeteria) (USDOJ, MMS, 2006b). See also the human health discussion in the Environmental Justice analysis in Section 4.4.1.15.

Any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. Although onshore and offshore cumulative effects are difficult to separate, most cumulative effects are thought to result from onshore development. To date, no comprehensive onshore monitoring or baseline data gathering has ever been undertaken by responsible Federal and State agencies and industry; the most obvious cumulative effects have occurred and continue to occur onshore, as oil-field development expands westward from the initial Prudhoe Bay/Deadhorse area of development. Proposed and ongoing studies that will contribute to a more comprehensive understanding of cumulative and human health effects to the Native population of the North Slope are discussed in the Environmental Justice cumulative effects analysis Section 4.4.1.15.8 (USDOJ, MMS, 2006b); for a general discussion of Environmental Justice, see Section 4.4.1.15.

Conclusion. Cumulative effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from on-and offshore exploration, development and production activities; small changes in population and employment; and disruption of subsistence-harvest patterns from seismic noise disturbance, oil spills and oil-spill cleanup, and climate change. Accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion), social organization, or sociocultural systems (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2006b). However, if a large oil spill occurred and

contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (USDOI, MMS, 2003a, 2006b; USDOI, BLM and MMS, 2003).

In this cumulative analysis, the level of effects would increase because collectively, activities would be more intense. More air traffic and non-Natives in the North Slope region could increase interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow, Atqasuk, and Kaktovik (USDOI, MMS, 2003a).

Effects from anticipated 3D seismic surveys and exploration should not exceed moderate effects levels with the application of mitigation measures, especially Stipulation 5 that provides for an Adaptive Management Mitigation Plan that reduces potential conflicts between oil industry activities and subsistence whalers. For 3D and 2D seismic surveys and exploration, which are projected to occur for at least 3 years, effects to sociocultural systems are expected to be moderate. Effects to social well-being (social systems) could be noticeable because of concern over deflection of the bowhead whale due to seismic-survey activities and the attendant effects on subsistence harvests. These concerns may translate into greater activity, as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If deflection actually occurred, effects could be major.

At the regional level, offshore effects to sociocultural systems from routine activities from exploration, development and production, and decommissioning (abandonment), would cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level—a moderate effect. At the local level, effects from routine development could exceed a major level of effect. Additionally, effects from a large oil spill would exceed a major level of effect, because noticeable disruption in excess of 2 years could occur from a large spill when combined with cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns. State and Federal mitigation measures should prove effective in ameliorating many of the cumulative effect discussed. Social systems will successfully respond and adapt to the change brought about by the introduction of these activities. If development and production occur, the accommodation response in itself could represent a major impact to social systems.

On- and offshore, as the area impacted by oil development in the future increases, especially in proximity to local communities; cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atqasuk currently depend on subsistence caribou harvest from the CAH and the TCH; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns, including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources; social bonds; and cultural values. If oil and gas development occurs near the north shore of Teshekpuk Lake, and is connected by roads and pipelines to the Alpine field, an important subsistence use area used by residents of Nuiqsut, Barrow, and Atqasuk could be avoided by subsistence users. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence-resource-harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment (USDOI, BLM, 2004; USDOI, BLM and MMS, 1998).

Industrialization clearly displaces subsistence users from traditional use areas even if no legal impediments to access are imposed (NSB, 2003). Essentially, potential effects include disturbance of traditional use and archaeological sites, such as hunting, fishing, and whaling camps, by construction and the increased possibility for vandalism. Any effects to these resources would have a corresponding and proportional effect on cultural value. If development occurred in areas containing concentrations of subsistence cabins, camps, and traditional-use sites and subsistence resources experienced only minor impacts, subsistence users would be displaced and impacts would be expected to be far greater. The BLM expects its subsistence stipulations to mitigate potential exploration and development conflicts with subsistence cabins, camps, and use sites (USDOI, BLM and MMS, 2003; USDOI, BLM, 2007d).

If a large spill contacted and extensively oiled coastal habitat, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Such impacts would be considered major. All subsistence-whaling communities and other communities that trade for and receive whale products and other resources from the whaling communities could be affected. A large spill anywhere within the habitat of bowhead whales or other important marine mammal subsistence resources could have multiyear impacts on the harvest of these species by all communities that use them. In the event of a large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. In addition, harvests could be affected by the IWC, which could decide to limit harvest quotas in response to a perceived threat to the bowhead whale population (USDOI, MMS, 2003a, 2006b; USDOI, BLM and MMS, 2003).

Beyond the impacts of a large spill, long-term deflection of whale migratory routes or increased skittishness of whales due to increasing seismic surveys and industrialization in the Beaufort Sea would make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated although a predominant concern continues to be potential disruption associated from seismic survey noise on subsistence-harvest patterns, particularly on the bowhead whale—a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Such disruptions could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems (USDOI, MMS, 2006a).

Onshore, because Nuiqsut is relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community—a major effect; however, overall effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. This same potential exists for the communities of Barrow, Atkasuk, and Kaktovik as Beaufort Sea areawide leasing, exploration, and development proceeds on- and offshore. Any potential effects to subsistence resources and subsistence harvests and consequent impacts on sociocultural systems are expected to be mitigated substantially by in-place mitigation, though not eliminated (USDOI, MMS, 2003a, 2004, 2006b).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and, considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses, as well as impacts to population, employment, and local infrastructure.

The termination of oil activity could result in the outmigration of non-Inupiat people from the North Slope, along with some Inupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally constrained, postoil-production environment. If subsistence livelihoods are disrupted, Inupiat communities could face increased poverty, drug and alcohol abuse, and other social problems resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on nonsubsistence foods (Langdon, 1995, Peterson and Johnson, 1995, National Assessment Synthesis Team, 2000, IPCC, 2001).

As stated by Parson et al. (2001): “It is possible that projected climate change will overwhelm the available responses.” It also is realistic to expect that some general assistance could be found to mitigate the losses of nutrition, health, and income from diminished subsistence resources, but such assistance would likely have little effect in mitigating the associated social and cultural impacts. If present rates of climate change continue, impacts to subsistence resources and subsistence harvests—and consequent impacts on sociocultural systems—would be expected to be major (USDOJ, MMS, 2006b, 2007d).

4.4.2.14. Archaeological Resources.

Summary. Generally, potential effects from activities increase with the level of activities, from the exploration phase to the development phase. Potential effects on archaeological resources would be from exploration and development activities on both onshore and offshore resources, including historic and prehistoric. Onshore resources are more at risk for effects from disturbance caused by construction or oil-spill-cleanup operations. Potential offshore resources are at greater risk for effects from bottom-disturbing activities, notably anchor dragging and pipeline trenching. If extended-reach drilling techniques are used instead of offshore platforms or islands, possible offshore effects would be minimized. For onshore archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations. Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. Any archaeological resources, either onshore or offshore, will be identified before any activities are permitted, and they will be avoided or potential effects mitigated; therefore, only negligible to minor impacts on archaeological resources are anticipated.

4.4.2.14.1. Anticipated Effects to Archaeological Resources. Archaeological resources in the Beaufort Sea Planning Area are subject to the same potential effects described in Sections 4.4.1.14.1.1 to 1.4 and the same cumulative past, present, and reasonably foreseeable actions described in Sections 4.4.1.14.5. This section describes the impact on archaeological resources under Alternative 2, and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency undertakes such actions. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures are described in Section 4.4.1.14.2.

4.4.2.14.1.1. Anticipated Effects from Disturbance. Archaeological resources in the Beaufort Sea Planning Area are subject to the same potential effects from disturbance described in Section 4.4.1.14.1.1; the same anticipated effects described in Section 4.4.1.14.3.1; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.14.5 for the Beaufort Sea no-action alternative.

4.4.2.14.1.2. Anticipated Effects from Oil Spills and Oil-Spill Response and Cleanup. Effects on archaeological resources from oil spills and oil-spill response and cleanup were described in Section 4.4.1.14.1.2; the same anticipated effects were described in Section 4.4.1.14.3.2, and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.14.5 for the Beaufort Sea no-action alternative. The potential for oil spills to contact terrestrial areas in the Beaufort Sea Planning Area was discussed in the oil-spill analysis Section 4.4.2.12.1.4.1.1 under the Subsistence-

Harvest Patterns Proposed Action Alternative 2. A large spill from a well blowout is described as a very unlikely event, and no large oil spills are assumed to occur during exploration (Appendix A, Section 1.1.4).

4.4.2.14.1.3. Anticipated Effects from Seismic Surveys. Archaeological resources in the Beaufort Sea Planning Area are subject to the same potential effects from seismic surveys described in Section 4.4.1.14.1.3; the same anticipated effects described in Sections 4.4.1.14.3.3; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.14.5 for the Beaufort Sea no-action alternative.

4.4.2.14.1.4. Anticipated Effects from Onshore Development. Archaeological resources in the Beaufort Sea Planning Area are subject to the same potential effects from onshore development described in Section 4.4.1.14.1.4; the same anticipated effects described in Section 4.4.1.14.3.4; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.14.5 for the Beaufort Sea no-action alternative.

4.4.2.14.2. Direct and Indirect Effects Under Alternative 2.

Summary. The following analysis describes only the anticipated effects on archaeological resources that are most likely to occur if the MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.14.2 and 4.4.1.14.3. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on environmental justice if such a discovery is made and proposed for development in the more distant future.

All development drilling, constructing, and mining activities, similar to those noted for exploration, have the potential to affect prehistoric and historic archaeological resources. Development activities increase the potential for effects, because they are more frequent, more concentrated, and last longer. In addition, development would require the construction of pipelines offshore and onshore. Activities associated with leases that affect the seafloor have the potential to disturb prehistoric archaeological resources in water depths <60 m. This is based on past sea level history only. No prehistoric resources are expected in some areas of the shelf in water depths <60 m where (1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section. However, these are not well defined and will have to be determined on a case-by-case basis. High-resolution seismic data from site-clearance surveys will reveal these features and sediment thickness (see Figures 3.4.4-1 Archaeology Blocks and General Location of Shipwrecks in the Beaufort Sea Planning Area, and 3.4.4-2 Archaeology Blocks and General Location of Shipwrecks in the Chukchi Sea Planning Area). The likelihood of historic resources such as shipwrecks, abandoned relics of historic importance, or submerged airplanes, is determined by historical records and their areas are tentatively identified in the Alaska Shipwreck database (see Figures 3.4.4-1 and 3.4.4-2). There may be other occurrences of historic resources, and these will be determined during survey work.

Physical disturbance of resources could damage or destroy buildings, shipwrecks, sites, or artifacts, or cause a loss of site context with resulting loss of archaeological data or artifacts. Archaeological resources are nonrenewable. Archaeological surveys conducted before any activity onshore or offshore will identify potential resources, and they will be avoided or detrimental effects mitigated.

Any offshore activity that disturbs the seafloor in water depths <60 m in areas not identified as having high-density ice gouging, has the potential to affect prehistoric and historic shipwreck archaeological resources. Any activity that disturbs the seafloor in water >50 m has the potential to affect historic resources such as shipwrecks, abandoned relics of historical importance, or airplanes. It is not only the intensity of ice-gouging evident at the seafloor, but the depth to which sediments have been reworked by ice gouging that is important. If the Holocene sediments are thick enough in an area (and this would be especially true where Holocene sediments are infilling a relict Pleistocene channel feature), prehistoric sites may have survived intact, regardless of the severity of ice gouging at the seafloor. This can only be determined after a high-resolution seismic survey is conducted of the area. Activities that have the potential to disturb offshore archaeological resources include anchoring; pipeline trenching, excavating of well cellars, emplacement of bottom-founded platforms, and use of ocean-bottom cables for seismic data collection.

Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Any activity that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Activities that could damage previously unidentified onshore archaeological resources include installation of rigs for extended-reach drilling, construction of gravel pads, year-round roads, pipeline construction and installation, • gravel mining, and oil-spill-cleanup activities in the event that a large spill occurs.

In the Chukchi Sea Planning Area, pipeline construction in the area of Peard Bay and seaward in a northerly direction could disturb historic shipwreck resources where accounts have identified five whaling barks wrecked since 1871, two steam whalers wrecked in 1897, and another steam freighter wrecked in 1924. In the Beaufort Sea Planning Area, pipeline construction seaward west or east of Barrow could disturb historic shipwreck resources where accounts have identified eleven whaling barks and ships wrecked since 1876 (see Table 3.4.5-2).

Prehistoric archaeological sites could be affected by activities that disturb the surface or shallow subsurface area. Such activities include:

- Removal of conductor casing (about 1-m in diameter), which extends from the surface down to depths of 75-100 m, disturbs all soil inside the casing.
- Constructing a gravel pad or year-round road construction that removes soil layers or causes shallow permafrost to thaw.
- Gravel mining, particularly along the trend of paleo-riverbanks or buried over-bank deposits.
- Emplacement of bottom-founded platforms may compress Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata. Drillship anchors may disturb host or overlying sediment.

Bottom-founded structures could damage or disturb potential shallow archaeological resources, if dragging and sliding of the base-plate or skirt occurs on the seafloor when the structure is set down or removed. Penetration of the skirt could occur to a depth of approximately 2 m. However, geophysical and archaeological surveys would identify any such resource before the platform is moved and the resource would be avoided or potential effects mitigated. The placement of a bottom-founded production platform may compresses Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata, including potential prehistoric archaeological resources.

Floating drilling platforms could disturb the sea floor and buried archaeological resources by anchor-drag during the setting of anchors or movement of the drillship or support vessels over the anchor-spread area.

In addition, floating drilling platforms require the excavation of a well cellar for burying of the blowout preventor stack beneath the seafloor surface, which could affect an archaeological site.

Onshore, historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the DEW system could be affected by increased human activity and construction in remote areas and the increased possibility for vandalism. Prehistoric sites, although often not as visible as historic sites, also might be subjected to increased vandalism.

Onshore pipelines would be elevated with vertical support members (pilings). These probably would disturb 2 ft^2 (0.2 m²) of soil to a depth of several tens of feet (tens of meters), but could penetrate soil horizons of potential archaeological significance. Any archaeological site beneath or near the pipeline right-of-way has the potential for being disturbed by the construction of roads and installation of the pipelines. Road construction has the potential to disturb archaeological sites through the removal of potential layers containing site deposits, or by thawing of shallow permafrost.

The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed when mitigation is applied during cleanup activities. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the EVOS, <math><3\%</math> of the resources within the spill area were be significantly affected, and impacts would most likely be minor to moderate. Various mitigating measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991).

Conclusion. Generally, potential effects from activities increase with the level of activities, from the exploration phase to the development phase. Potential effects on archaeological resources would be from exploration and development activities on both onshore and offshore resources, including historic and prehistoric. Onshore resources are more at risk for effects from disturbance caused by construction or oil-spill-cleanup operations. Potential offshore resources are at greater risk for effects from bottom-disturbing activities, notably anchor dragging and pipeline trenching. If extended-reach drilling techniques are used instead of offshore platforms or islands, possible offshore effects would be minimized. For onshore archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations. Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. Any archaeological resources, either onshore or offshore, will be identified before any activities are permitted, and they will be avoided or potential effects mitigated; therefore, only negligible to minor impacts on archaeological resources are anticipated.

4.4.2.14.3. Cumulative Effects Under Alternative 2.

Future Sales 209 and 221 in the Beaufort Sea and Sales 211 and 221 in the Chukchi Sea and other ongoing projects in the region are summarized in Section 4.2.1 and include:

- 1) ongoing maintenance and development projects in local communities;
- 2) onshore oil and gas infrastructure development;
- 3) passenger, research, and industry-support aircraft activities; and

- 4) local boat traffic, barge resupply to local communities, research vessel traffic, industry-support vessel activities (mostly in support of seismic surveys), an increasing U.S. Coast Guard presence, and vessel traffic from increasing Arctic ecotourism.

Ongoing actions include:

- 1) development and production activities at Endicott, Northstar, Badami, and Alpine;
- 2) recent leasing from Beaufort Lease Sales 195 and 202;
- 3) State leasing; and
- 4) onshore leasing activity in the NPR-A.

Other projects include BP's restart of the Liberty Development Project east of Endicott; Pioneer Natural Resources Co.'s development of its North Slope Oooguruk field in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit; and the Nikaitchug Development Project, also in State waters off the Colville Delta. In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling off the Mackenzie River Delta in and GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area (USDOJ, MMS, 2006a).

In the Chukchi Sea, west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the DeLong Mountain Terminal. These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the planning area (USDOJ, MMS, 2006a).

Summary. Anticipated effects under the Proposed Action are combined with the anticipated effects of the no-action alternative (see Section 4.4.1.14.5) to determine the cumulative effects for this alternative. Disturbance effects would be associated with OBC seismic surveys, drilling activities, construction activities and oil spills.

The greatest cumulative effect on archaeological resources in the Beaufort and Chukchi seas is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area.

Accidental oil spills would affect onshore archaeological sites the most, but past cleanups have shown us that spilled oil had little direct effect on archaeological resources (Bittner, 1993). Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Mitigating measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991).

Although archaeological resources are not renewable, they are not affected directly or cumulatively by oil spills, the build up of toxic substances, noise, or air pollution. Effects are minimized due to modern technologies and practices that reduce the impact to the environment and therefore to archaeological resources (no thawing of permafrost, restricted personnel access, wintertime operations, small-footprint drilling and transportation technologies). Furthermore, mitigating measures, such as offshore high resolution seismic surveys with archaeological analyses in zones of potential resources, and onshore

archaeological surveys where offshore pipelines make landfall, would avoid damage or destruction of potential archaeological resources.

Cumulatively, proposed oil and gas projects in the region likely would disturb the seafloor, but remote-sensing surveys made before approval of any Federal or State lease actions should keep these effects low. Federal laws would preclude effects to most archaeological resources from these planned activities.

Conclusion. Generally, potential effects from activities increase with the level of activities, from the exploration phase to the development phase. Potential effects on archaeological resources would be from exploration and development activities on both onshore and offshore historic and prehistoric resources. Onshore resources are more at risk for effects from disturbance caused by construction or oil-spill-cleanup operations. Potential offshore resources are at greater risk from effects from bottom-disturbing activities, notably anchor dragging and pipeline trenching. In the exploration phase, some drilling could take place in deeper water, using floating drilling platforms or ships. These drilling units would use anchors and would probably have their blowout preventor buried, which could disturb potential archaeological resources in the immediate area. No impact is expected to prehistoric archaeological resources from activities in water depths >50 m. In the development phase, floating drilling and production platforms and possibly subsea production well-head assemblies would have the same disturbance effects on the seafloor as in the exploration phase: anchor dragging and digging the glory hole. The effect of gravel islands or bottom-founded production systems would be the compression and skirt penetration of sediments.

Ocean-bottom-cable seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water. Such offshore seismic-exploration activities could disturb these resources and their in situ context. The application of MMS mitigation would be expected to identify and avoid any potential prehistoric and historic archaeological resources. Therefore, only negligible to minor impacts to archaeological resources are anticipated.

Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. Cumulatively the potential impacts to both prehistoric and historic archaeological sites from regional oil and gas activities in the region should be largely eliminated due to archaeological surveys which are required prior to disturbance. Any archaeological resources, either onshore or offshore, will be identified before any activities are permitted, and they will be avoided or potential effects would be mitigated. Therefore, only negligible to minor impacts to archaeological resources are anticipated.

Some impact may occur to coastal historic and prehistoric archaeological resources from accidental oil spills. For these archaeological resources, the potential for effects increases with oil-spill size and associated cleanup operations, and primary oil-spill impacts to both prehistoric and historic archaeological sites would be expected to result from cleanup activities. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the EVOS, where <3% of the resources within the spill area were significantly affected, the impact would most likely be minor to moderate.

4.4.2.15. Environmental Justice.

Summary. The following analysis describes only the anticipated effects on EJ that most likely would occur if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.12.2 and 4.4.1.15.5. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on EJ if such a discovery is made and proposed for development in the more distant future.

Impacts on EJ could occur from disturbance and noise effects to subsistence resources and practices and sociocultural systems in the coastal communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would be expected to avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on subsistence resources and practices, sociocultural systems, and public health and produce consequent major impacts on EJ.

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from oil exploration and development activities, from changes in population and employment, and subsistence-harvest patterns. Accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion), social organization, or sociocultural systems (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2006b). Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices, sociocultural systems, and public health.

4.4.2.15.1. Anticipated Effects to Environmental Justice. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects described in Section 4.4.1.15.2 and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8. This section describes the impact on EJ under Alternative 2, the Proposed Action, and adding it to other past, present, and reasonably foreseeable future actions, regardless of what agency undertakes such actions. Reasonably foreseeable future actions are described in Section 4.2. Mitigation measures are described in Sections 4.4.1.12.2 and 4.4.1.15.5. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiat population.

Public Health in the Beaufort Sea Planning Area is subject to the same potential effects described previously in section 4.4.1.15, and the same cumulative past, present, and reasonably foreseeable actions described in there. This section describes the impact on public health under Alternative 2, the Proposed Action, and adding it to other past, present, and reasonably foreseeable future actions regardless of what agency or entity undertakes such actions. Reasonably foreseeable future actions are described in

Section 4.2. Mitigation measures are described in Section 4.4.1.12.2. New potential mitigation measures to address public health issues from oil and gas development are presented and discussed in Appendix J.

4.4.2.15.1.1. Anticipated Effects from Disturbance. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from vessel and aircraft disturbance described in Section 4.4.1.15.2.1; the same anticipated effects described in Section 4.4.1.15.5.1; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Oil and gas exploration and development in the Beaufort Sea region could result in disturbance to marine mammal resources and harvests. It is hoped that mitigation measures imposed by MMS on future exploration and development activities would minimize adverse effects to these resources. Vessel and aircraft disturbance associated with the Proposed Action is anticipated to have a minor effect on marine mammal resources and subsistence harvests in the Beaufort Sea Planning Area.

Public health impacts related to disturbance would occur in proportion to the interruption or interference with subsistence activities. General health and well-being and psychosocial problems could be affected if disturbances resulted in hunting or whaling failures. More difficult subsistence conditions or failed hunts could lead to stress and maladaptive coping strategies (increased alcohol or drug use, domestic violence). If whales were displaced or made more skittish by aircraft and vessel disturbances, injuries could result. Similarly, on land, caribou displacement or behavioral changes in response to aircraft disturbances could lead to the need to travel greater distances to harvest caribou. Snowmachine accidents have been shown to occur in proportion to the miles traveled, so this could increase the risk of accidents for hunters on land (Landen, Middaugh, and Dannenberg., 1999). Because it is anticipated that displacement would not be severe enough to render resources unavailable to hunters (see Section 4.4.1.12), it is possible but unlikely that vessel and aircraft disturbance effects on nutrition, diet, and related health problems would occur. Overall, because the effects of disturbance on subsistence harvests are projected to be minor, health effects from disturbance are likely to be negligible. The exception would be if isolated injuries occurred secondarily to whales becoming more aggressive or being displaced into rougher waters. Injuries related to displacement of whales would constitute a moderate to major impact.

Mitigation. Mitigation measures such as the AMMP and IHA agreements, if implemented effectively, would be expected to minimize the chance of injuries occurring.

4.4.2.15.1.2. Anticipated Effects from Discharges. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from discharges described in Section 4.4.1.15.2.2; the same anticipated effects described in Section 4.4.1.15.5.2; and the same cumulative past, present, and reasonably foreseeable actions previously described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Current water quality in the Arctic OCS is relatively pristine, and present industrial impacts are minimal. The potential effects on public health from discharges are described in section 4.4.1.15.2.2. Exposure to discharges could occur directly (through contact with contaminated water), or through contact with contaminated subsistence resources. As noted in section 4.4.1.15, concern about contaminants is a powerful determinant of people's confidence in and use of subsistence resources.

The EPA NPDES General Permit issued for activities in Arctic waters is designed to establish discharge limits that protect human health. However, as described in section 4.4.1.15.2.2, there are legitimate

scientific questions that can be posed regarding the certainty of assumptions used to set acceptable levels of pollution. Because of the high importance of the OCS environment to subsistence practices and the health and wellbeing of local communities, the NSB undertook a review of the available literature used in reaching this conclusion, and notes that there are a number of assumptions and uncertainties on which this permit's conclusion is based. First, it must be noted that metals, including mercury, can be found not only in drilling muds but also in cuttings. Thus, the elevated metal concentrations sometimes seen in cuttings piles may be from a combination of cuttings, accumulation and migration from the natural sediment, from discharges of barite, from specialty chemicals in drilling muds, from the platform itself (i.e., paint chips, corrosion) and from aeolian input. The introduction of oxygen, the amount and types of specialty chemicals, and the oil content of the cuttings all are variables that influence the kinetics, chemistry, and timeframe associated with the sorption (binding) and desorption (release) of metals bound up in the cuttings piles. Additionally, disruption of tailing piles may release large concentrations of metals as a result of oxidation of metal sulfide complexes. No field work has demonstrated that the metals found in cuttings piles are likely to remain in a “bound” (and, therefore, less bioavailable) form (Rosa, pers. comm., 2008). Another potential concern for human health associated with OCS discharges is “naturally-occurring radioactive material” (NORM), which is present in the shales from which oil and gas are extracted. During extraction, reactions can occur that result in dissolved radionuclides remaining in solution in the drilling fluids or precipitating and becoming incorporated into the solid components of drill cuttings. This process depends on water chemistry, temperature, and pressure. Chronic exposure to radiation may result in mortality, mutagenesis, or decreased fertility or sterility for exposed organisms (Holdway, 2002). A final data gap that limits the ability to accurately predict potential health effects from discharges is the lack of quantitative nutritional data, which would be necessary to accurately model the potential exposure of subsistence users to contaminants from OCS discharges. Given these limitations, for widely interspersed exploratory drilling, it may be reasonable to conclude that the risks are relatively low; on the other hand, as activities in the planning area and adjacent OCS areas intensify, the accumulation of contaminants in the Arctic OCS ecosystem could become a more substantial concern.

Contamination of subsistence resources through bioaccumulation, depending upon the specific pollutant, would pose a risk of cancer, teratogenesis, or neurodevelopmental delay. Community concern over potential contamination from activities under this alternative, coupled with acknowledged data gaps, could influence fears that contaminants from OCS activities may impact subsistence resources, and could be a substantial source of stress in impacted communities. Contamination and the perception of contamination of subsistence resources may also affect the use of subsistence foods through reduced or abandoned harvests, increased stress about the effects of consuming possibly tainted food, concerns about future availability of subsistence resources, and a decline in the satisfaction of eating subsistence food sources; fears regarding contamination have been shown to influence consumption of subsistence resources (Ballew et al., 2004; Poppel et al. 2007). Reduced consumption of subsistence foods would increase the risk of food insecurity, nutritional deficiencies, and chronic diseases such as diabetes, high blood pressure, and cardiovascular disease.

Mitigation. The newly adopted BLM ROP A-11 would reduce concerns about contaminants from onshore oil and gas operations through ensuring adequate baseline data on current contaminant levels, and through monitoring contaminants produced from onshore operations in subsistence resources; this measure provides for BLM intervention if levels of contaminants reach levels that could pose a risk to the human population. Appendix J describes new potential mitigation measures for public health.

4.4.2.15.1.3. Anticipated Effects from Oil Spills. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from oil spills described in Section 4.4.1.15.2.3; the same anticipated effects described in Sections 4.4.1.15.5.3; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative.

Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems. The potential for oil spills to contact subsistence resources and harvest areas in the Beaufort Sea Planning Area was discussed in the oil-spill analysis Section 4.4.2.12.1.4.1 for the Subsistence-Harvest Patterns Alternative 2. While spills can occur on land or in the marine environment, spills to the marine environment have the greatest potential to affect marine mammals important for the subsistence harvest. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems. The same mitigation measures described in Section 4.4.1.12.2 would be implemented for the proposed lease sales. A large spill from a well blowout is described as a very unlikely event and no large oil spills are assumed to occur during exploration (Appendix A, Section 1.1.4).

Public health in the Beaufort Sea region is subject to the same potential effects from large oil spills described in Section 4.4.1.15.2.3, and the same anticipated and cumulative past, present, and reasonably foreseeable future actions previously described there. The anticipated public health effects from a large spill under this alternative would be the same as these effects, if a spill actually occurred. In the absence of an actual spill, it must be acknowledged that the fear of a large spill creates significant health effects. Stress created by the fear of an oil spill is a distinct impact-producing agent within the human environment. Stress from this general fear can be broken down to the specific fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- the lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- the lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- the need to employ and work with lawyers in drafting litigation to attempt to stop proposed development (USDOJ, MMS, 2003a; USDOJ, BLM and MMS, 2003).

The impacts of recently increased interest in OCS leasing, such as the unanticipated high bidding for tracts in Lease Sale 193, coupled with Shell's submission of an exploration permit application, have intensified fears in local communities where residents must face the very real possibility that an era of active OCS exploration and development is beginning. Stress and anxiety are health effects in their own right and can contribute, as well, to other problems such as psychosocial health problems (violence, drug and alcohol abuse, suicide), as well as physical health problems for which stress is a well-documented risk factor, such as cardiovascular disease and exacerbations of asthma. These problems would be particularly likely in individual communities near a major exploration or development project.

Mitigation. Appendix J describes new potential mitigation measures for public health.

4.4.2.15.1.4. Anticipated Effects from Oil-Spill Response and Cleanup. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from oil-spill response and cleanup described in Section 4.4.1.15.2.4; the same anticipated effects described in Section 4.4.1.15.5.4; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Public health in the Beaufort Sea region is subject to the same potential effects from oil-spill response and cleanup described in Section 4.4.1.15.2.4, and the same anticipated and cumulative past, present, and reasonably foreseeable future actions previously described there. The anticipated public health effects from a large spill under this alternative would be the same as the potential effects, if a spill actually occurred. The influx of personnel, and sudden employment and income increase for some local residents could impact public health. A large, uncontrolled influx of nonresident cleanup personnel to or through villages would increase the change of infectious disease transmission. The rapid increase in income coupled with subsistence impacts and the potential that alcohol or illicit drugs might be brought into the region by transient cleanup personnel creates a risk for increased alcohol and substance abuse. Hunters now providing subsistence foods for the community might spend less time hunting if employed in cleanup, which would create nutritional impacts on the community.

Mitigation. Appendix J describes new potential mitigation measures for public health.

4.4.2.15.1.5. Anticipated Effects from Airborne Emissions. Public health in the Beaufort Sea Planning Area is subject to the same potential effects from airborne emissions as those described in Section 4.4.1.15.2.5, and the same cumulative past, present, and reasonably foreseeable actions previously described there. As noted by the ADEC, however, “transport and deposition of pollution downstream of the North Slope facilities may be having a noticeable effect on the environment of the NPR-A. Currently, no data has been collected to document if the substantial amount of pollution emitted on the North Slope, although not in violation of air standards, may be having a significant cumulative effect on this area” (ADEC, 2007). The same gaps in baseline data apply to the Beaufort OCS, particularly west of the Alpine oilfield, the farthest west air quality monitoring site currently on the North Slope. Monitoring data are, therefore, not sufficient to allow determination of the contribution of current oilfield emissions to air quality in Barrow or other villages remote from Prudhoe Bay, relative to the contributions of other known sources in Northern Europe and Asia. Because of the distances from the most likely developments to Beaufort Sea coastal communities and the relatively small sizes of anticipated development in the Beaufort compared to the Prudhoe Bay complex, however, the proposed sale should have little to no effect on the air quality of coastal communities.

Airborne emissions from OCS activities pose two potential concerns. Subsistence users could be impacted if whaling or other hunting activities are occurring near or downwind from OCS facilities. Emissions from these facilities could cause exacerbations of chronic lung disease or asthma, and cardiovascular events (heart attacks, arrhythmias). Given the size of the planning area relative to areas frequented by hunters, it is anticipated that such events would be rare. Secondly, HAPs emissions could contact subsistence users in the area, and others (particularly PAHs) could be deposited in the aquatic environment and could accumulate in subsistence species. Overall, effects from airborne emissions would be moderate although if exposure to contaminants resulted in a problem, such as cancer or heart attack in an individual, this would be considered a major effect.

Mitigation. The newly adopted BLM measure ROP A-10 would ensure adequate evaluation and monitoring of air pollution from onshore facilities, and provide a mechanism for adaptive management if oil and gas operations were found to be contributing to the risk for adverse health outcomes. Appendix J describes new potential mitigation measures for public health.

4.4.2.15.1.6. Anticipated Effects from Seismic Surveys. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from seismic surveys described in Section 4.4.1.15.2.6; the same anticipated effects described in Section 4.4.1.15.5.6; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.5.8 for the Beaufort Sea

no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Public health in the Beaufort Sea Planning Area is subject to the same potential effects from seismic surveys as those described in Section 4.4.1.15.2.6, and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8. Given the level of potential seismic-survey activity described in the scenario—up to three concurrent seismic surveys seasonally in the Beaufort Sea—and past assessments of species and resource effects discussed above, whales, pinnipeds, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing major impacts. Protective mitigation measures incorporated into seismic-survey permits, required industry Adaptive Management Mitigation Plans (AMMPs), and required mitigation under IHA requirements, as defined by NMFS and FWS is expected to reduce noise disturbance impacts (USDOJ, MMS, 2006a), so that no unmitigable adverse effects to subsistence resources and harvest practices occur. However, as pointed out by the NSB at the Open Water meetings in 2008, the current and projected increases in seismic exploration activity in the Beaufort has already begun to overwhelm agency capacity to monitor impacts and industry and agency ability to coordinate efforts with whalers. Hence, it cannot be stated with certainty that present mitigation will prove effective.

Adverse health effects from seismic surveys would relate to impacts to subsistence resources and harvests. As described in Section 4.4.1.15 for Alternative 1, public health and well-being in the NSB depend to a large extent upon subsistence resources. Disruption of subsistence harvests of whales, belugas, and pinnipeds, and polar bears from seismic activity could disrupt the central Inupiat cultural value (subsistence), the foundation of the North Slope nutritional system, and sharing networks, and, thereby, would adversely affect indicators of general health and well-being and could adversely impact the rates of psychosocial problems such as family violence, drug and alcohol problems, depression, anxiety, and suicide. Displacement of whales from their normal migration routes could increase the risk involved in hunting them, increasing the risk of accidents and injuries. Unpredictable behavior of whales disturbed by seismic activity would compound this risk. Displacement of whales could also result in longer towing times increasing the risk of spoilage. Food insecurity would thus likely increase as a result of harvest failures, and the severity of this problem would be proportional to the number and extent of failures and to the effects on extended sharing networks that reach outside the affected community. Store-bought foods would not be expected to provide adequate replacement micronutrients, and micronutrient deficiencies and anemia could result. If it became necessary to replace subsistence calories with store-bought foods, this would incrementally increase the risk of metabolic syndrome disorders including diabetes, hyperlipidemia, and high blood pressure, with the severity of this problem correlating with the severity and frequency of impacts to subsistence. These effects would be most prominent in Nuiqsut, where impacts from onshore development have resulted in some restriction of the traditional subsistence range on land (USDOJ, BLM, 2007), but other coastal villages in the planning area could also be affected. The Proposed Action could intensify these effects through making a larger area available for seismic exploration, which could occur in and near key OCS subsistence areas. If harvest disruptions were infrequent, intermittent events effects would be moderate; if they became more common or occurred over consecutive seasons, health effects would be major.

Mitigation. Appendix J describes new potential mitigation measures for public health.

4.4.2.15.1.7. Anticipated Effects from Habitat Loss. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from habitat loss described in Section 4.4.1.15.2.7; the same anticipated effects described in Section 4.4.1.15.5.7; and the same cumulative past, present, and reasonably foreseeable actions described in Sections 4.4.1.15.5.8 for the Beaufort Sea no-action

alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Public health in the Beaufort Sea Planning Area is subject to the same potential effects from habitat loss as those described in Section 4.4.1.15.2.7, and the same cumulative past, present, and reasonably foreseeable actions previously described there. Permanent habitat loss would only arise from the construction of development and production facilities (an offshore platform, undersea pipeline, pipeline landfall to an onshore base, and onshore, a shore base/processing facility and a pipeline linking to existing infrastructure). The public health effects of habitat loss would be expected to mirror impacts to subsistence resources: the health implications of such impacts are described in detail in Section 4.4.1.15.2.7. An additional concern would be stress and dysphoria caused by the proliferation of industrial infrastructure within view of communities, subsistence camps, and hunting routes. As noted by the NSB health director, Inupiat people are accustomed to an expansive, predominantly flat natural landscape with little interruption by vertical elements such as mountains, buildings (other than within villages), or other infrastructure (Habeich, pers. comm., 2007). The visuospatial changes created by pipelines, pads, rigs, and facilities associated with oil and gas development may have significant implications for people's relationship with the natural environment, sense of well-being, and psychological health.

4.4.2.15.1.8. Anticipated Effects from Onshore and Offshore Development. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from onshore and offshore development described in Section 4.4.1.15.2.8; the same anticipated effects described in Section 4.4.1.15.5.8; and the same cumulative past, present, and reasonably actions described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

Several lease sales have already taken place in the NPR-A. Exploration programs, consisting of seismic testing and drilling using ice pads, are ongoing. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects from these activities on subsistence. One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A (S.R. Braund and Assoc., 2003a,b). These effects would continue under continued leasing. Most effects of disturbance still would be short term, but the extent and magnitude likely would increase (USDOI, BLM, 2005).

4.4.2.15.1.9. Anticipated Effects from Production Activities. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from production activities described in Section 4.4.1.15.2.9; the same anticipated effects described in Section 4.4.1.15.5.9; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.8 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

4.4.2.15.1.10. Anticipated Effects from Economic, Employment, and Demographic Change. Public health in the Beaufort Sea Planning Area is subject to the same potential effects from economic, employment, and demographic change as those described in Section 4.4.1.15.2.10 and the same cumulative past, present, and reasonably foreseeable actions previously described in Section 4.4.1.15.5.10. Economic effects could come from a combination of revenues to the NSB from taxation of onshore infrastructure; the CIAP program; employment (direct and indirect) for residents; Native Corporation revenues from business and land use agreements; inflation for goods and services in villages that experience significant flow of nonresident workers through the community; and increased demands on services and wear and tear on infrastructure. Demographic change would come from a combination of

influx of nonresident workers and emigration and immigration secondary to employment and economic opportunities. The economic analysis in Section 4.4.2.11 predicts relatively small overall impacts on economy and employment. Indirect and direct employment figures are given in Tables 4.4.2.11-1 and 4.4.2.11-2.

Overall, the economic effects of the lease sale could potentially serve to slow the predicted rate of economic contraction in the region related to decreasing production from onshore facilities. This would have benefits for water and sanitation and public health services administered by the NSB. Employment has mixed effects on subsistence: as described in detail in Section 4.4.1.15.2.10, income from employment can provide income for fuel and equipment, but hunters employed in resource development work outside of the community may spend less time hunting. The influx of a large number of nonresident workers from outside the area, particularly in the case of a shore base located near a village, or the staging of activities from a village, could result in increased social stress and tension, as described in Section 4.4.1.15.2.10, and this could exacerbate psychosocial health issues such as substance abuse, depression and anxiety, violence, and suicide. The influx of workers associated with oil and gas activities has been associated with drug and alcohol problems in some studies, as discussed in Section 4.4.1.15.2.10, and has been reported by residents of Nuiqsut. The influx of large number of nonresident workers could also reduce the efficacy of local prohibition ordinances, leading to higher rates of drug and alcohol abuse and injuries. Finally, the influx of nonresident workers could create an economic strain on NSB systems that protect health, including water and sanitation infrastructure, police staffing, EMS personnel, schools, roads and runways, and potentially others. Overall, if all the economic, employment, and demographic effects associated with the Proposed Action occurred, onshore effects would be major.

Mitigation. Appendix J presents the NSB's proposed mitigation measures for public health.

4.4.2.15.1.11. Anticipated Effects from Climate Change. Environmental Justice in the Beaufort Sea Planning Area is subject to the same potential effects from climate change described in Section 4.4.1.15.2.11; the same anticipated effects described in Section 4.4.1.15.8; and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.5.11 for the Beaufort Sea no-action alternative. Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices, sociocultural systems, and public health.

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses, if warming trends continue (NRC 2003b, ACIA 2004). Every community in the Arctic potentially would be affected by the anticipated climactic shift, and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of coastal communities in the Beaufort Sea. If the loss of permafrost and conditions beneficial to the maintenance of permafrost arise as predicted, there could be synergistic cumulative effects on infrastructure; travel; landforms; sea ice; river navigability; habitat; availability of freshwater; and availability of terrestrial mammals, marine mammals, waterfowl, and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC 2003b, ACIA 2004; USDOI, BLM, 2005; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; United Nations Environment Programme, 2005; Callaway, 2007).

Because potential climate change impacts on marine and terrestrial ecosystems in the Arctic would cause significant impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic and on Alaska's North Slope would be expected

to experience disproportionate, high adverse environmental and health effects. See Section 4.4.1.12.4.11 for a discussion of cumulative global climate change impacts on subsistence-harvest patterns.

Public health in the Beaufort Sea Planning Area under the proposed action is subject to the same potential effects from climate change as described in Section 4.4.1.15.2.11, and the same cumulative past, present, and reasonably foreseeable actions described in Section 4.4.1.15.5.11. The cumulative effects of climate change on health are likely to be complex and cannot be estimated with certainty. Climate change is likely to influence the distribution and availability of subsistence resources, the stability of local housing and infrastructure, regional economy and demographics, and direct climate-related health effects. As stated by the U.S. Climate Change Science Program, Alaska communities will be particularly vulnerable to: (1) extreme precipitation resulting in contaminated water and food supplies in areas with outdated water treatment plants; (2) wildfires resulting in degraded air quality contributing to asthma and COPD; and (3) “fewer cold waves and higher minimum temperatures,” which could reduce cold-related injury (Ebi, Sussman, and Wilbanks, 2008). The emergence of new infectious diseases is highly likely as warmer conditions allow vectors not seen in the Arctic to begin to survive there; early evidence of such changes has already been reported with the emergence of *V. parahemolyticus* as a pathogen in Alaska in 2004 (Ebi, Sussman, and Wilbanks, 2008). Ozone depletion is increasing in the Arctic and may lead to increases in UV related problems such as skin cancers.

Thinner ice has made conditions more difficult for spring whaling crews to land successfully harvested whales; unpredictable ice conditions and late freezeups have made it more difficult and dangerous for hunters to harvest and travel in the early season on land. According to the IPCC, these changes are likely to accelerate in coming decades (IPCC, 2007). The remoteness and limited sources of income in NSB communities may limit the ability to adapt and respond to the major challenges posed by accelerated erosion and infrastructure problems that are already beginning to be seen in Alaska (ACIA, 2004). As these stresses accumulate, it will become more difficult for communities to respond to other challenges such as more difficult subsistence harvest conditions, creating the risk that health disparities will be exacerbated.

Mitigation. Appendix J presents the NSB’s proposed mitigation measures for public health.

4.4.2.15.2. Direct and Indirect Effects Under Alternative 2.

Summary. The following analysis describes only the anticipated effects on EJ that most likely would occur if MMS opens the entire lease-sale area (no deferrals) in the Beaufort Sea. The anticipated effects consider mitigation measures and other important factors (timing, residence time and productivity, spatial extent, and environmental factors, etc.) described in Sections 4.4.1.15.3 and 4.4.1.15.5. Development and production activities could result from leases offered under the proposed lease sales. Production, however, is not anticipated until another commercially viable discovery is made in the OCS. Production is not reasonably foreseeable, but those activities associated with a speculative production project were analyzed to determine the anticipated effects on EJ if such a discovery is made and proposed for development in the more distant future.

Impacts on EJ could occur from disturbance and noise effects to subsistence resources and practices and sociocultural systems in the coastal communities of Kaktovik, Nuiqsut, Barrow, and Atqasuk. In the event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Major effects on subsistence resources and harvests,

particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would be expected to avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on subsistence resources and practices and sociocultural systems and produce consequent major impacts on EJ.

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from oil exploration and development activities, from changes in population and employment, and subsistence-harvest patterns. Accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion), social organization, or sociocultural systems (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2006b). Anticipated effects would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices and sociocultural systems.

The following analysis describes only the anticipated direct and indirect effects on public health if the MMS opens the entire Beaufort Sea lease sale area with no deferrals, in isolation from other actions possible cumulatively, as required by NEPA. Current thought in public health has suggested that descriptors such as “direct and indirect” may be misleading, because they can be seen as implying a causal linkage that is “indirect” is less robust or important as a determining factor for health status; these terms thus risk misplacing emphasis on causal relationships that appear more “direct,” when the more powerful epidemiologic associations may be based on risk factors that are less direct (Krieger, 2008). Statistically robust modern public health data have demonstrated that social, economic, and environmental conditions explain well over 50% of the difference in health status between subgroups in a society and, therefore, are among the most important causal associations for the field of public health (Marmot and Wilkinson, 2004; Lantz, House, and Lepowski, 2003; Pamuk et al., 1998).

Direct effects to public health could occur from exposure to contaminants through discharges, emissions, or oil spills during exploration, development, or production. A large oil spill contacting subsistence resources is possible in this scenario, but statistically fairly unlikely, based on the OSRA for this alternative. Noise associated with disturbance from increased air traffic could disrupt community wellbeing. An influx of nonresident workers (detailed in Section 4.4.2.11 and subsections) could lead to decreased community cohesion. Projects in the planning area would operate under NPDES and NAAQS standards, which are promulgated to protect health. Furthermore, most major emissions sources under this alternative would be located far from communities, either offshore or using existing industrial infrastructure onshore. Nevertheless, vulnerable groups (elders, young children, and people with chronic illnesses) may suffer adverse outcomes at levels of pollution substantially below these standards. The most likely scenario would be intermittent exposure from hunting activities, and possibly lower-level exposure under specific climate conditions.

The entire planning area would be open to leasing without deferrals under this alternative. This raises the chance that subsistence resources, harvests, or practices could be disrupted; disturbance from aircraft and vessels would be a factor throughout the life of the sale; up to three concurrent seismic operations would be permitted in the Beaufort Sea under this alternative; production platforms and activities, and onshore operations to support OCS development and production, if it occurred, also could displace subsistence resources. Subsistence impacts are associated with the following health effects: (1) undermining the protective aspects of the culture and social structure provided by subsistence, incrementally contributing to already elevated rates of social and psychological health problems; (2) food security could increase even with a major exploration proposal or with actual subsistence impacts; (3) if the harvest of one or more resources were restricted for more than one season, nutritional deficiencies could result; and (4)

increased accidents and injuries if subsistence hunters had to travel longer distances to contact resources, or if whales exhibited less predictable or more agitated behavior because of disturbances from activities under this alternative.

An influx of nonresident workers under this alternative (see Tables 4.4.2.11-1 and 4.4.2.11-2) could intensify cultural conflict and could undermine community cohesion, increasing the risk of psychosocial problems. Such an influx potentially also would be associated with the possibility of drug and alcohol importation, and this would be compounded by the need for additional police staff to adequately handle the flow of nonresidents through the villages. An influx of nonresident workers from outside the region also poses the risk of infectious disease transmission between low and high prevalence groups.

The modest economic and employment effects predicted in Section 4.4.2.11 would tend to stabilize the NSB economy, but may not offset gradual declines in revenues and employment from onshore oil and gas activity. Economy and employment are generally associated with improved overall health and less psychosocial strain. Economic inputs would also help prevent deterioration of water and sanitation infrastructure and could stabilize health and other services provided by the NSB.

The AAMPs and IHAs could reduce the risk of deflecting subsistence resources, but their efficacy has not been tested under conditions of multiple, concurrent activities in the region. Appendix J describes new potential mitigation measures for public health.

Conclusion. Effects from anticipated 3D seismic surveys and exploration should not exceed moderate effects levels. For 3D and 2D seismic surveys and exploration, which are projected to occur for at least 3 years, effects to sociocultural systems and consequent impacts on EJ are expected to be moderate. Effects to social wellbeing (social systems) could be noticeable because of concern over deflection of the bowhead whale due to seismic-survey activities and the attendant effects on subsistence harvests. These concerns may translate into greater activity as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If deflection actually occurred, effects could be major.

For routine activities from exploration, development and production, and decommissioning (abandonment), effects to sociocultural systems would cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level—a moderate level of effect on sociocultural systems and EJ.

For large oil spills, noticeable disruption in excess of 2 years could occur from a spill and from cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a chronic disruption of social organization, cultural values, and institutional organization. Such major sociocultural impacts would have a tendency to displace existing social patterns and would represent disproportionate high adverse EJ impacts on subsistence-based Alaska Native coastal communities in the region. Mitigation measures should prove effective in ameliorating many of these effects.

Major effects on subsistence resources and harvests, particularly from routine concurrent seismic surveys, would be anticipated, but mitigation measures described in Section 4.4.1.12.2 would be expected to avoid and minimize these effects to a moderate level. Potential long-term impacts from climate change would be expected to exacerbate overall potential effects on subsistence resources and practices, sociocultural systems, and public health and produce consequent major impacts on EJ.

4.4.2.15.3. Cumulative Effects Under Alternative 2.

Contribution of future OCS and other activities on subsistence resources and practices were discussed in Sections 4.4.1.12.7, and the same activities would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices sociocultural systems, and public health.

Summary. Anticipated effects of the Proposed Action are combined with the anticipated effects of the no-action alternative (see Section 4.4.1.15.8) to determine the cumulative effects for this alternative. The noise-producing exploration and construction activities are those most likely to produce disturbance effects on critical subsistence species that include bowhead and beluga whales, caribou, fish, seals, and birds. Disturbance effects would be associated with aircraft and vessel noise, construction activities, and oil spills; specifically: (1) seismic surveys that occur prior to an oil and gas lease sale; (2) aircraft support of exploration and development activities; (3) possible vessel supply and support of exploration and development activities; (4) drilling activities during the exploration and development and production phases; and (5) onshore construction, including pipeline, road, support-base, landfall, and pump-station construction. Noise and traffic disturbance would be a factor throughout the life of the sale.

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from oil exploration and development activities, oil spills and oil-spill cleanup, changes in population and employment, and subsistence-harvest patterns; accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion); social organization; or sociocultural systems. However, community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales from an oil spill (USDOI, BLM and MMS, 2003; USDOI, MMS, 2006b).

Offshore exploration and development in the Beaufort seas is expected to increase, with lease sales planned for the near future by MMS and the State of Alaska in this offshore area. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk might result from seismic-exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of people and equipment for seismic exploration. However, the possible long-term deflection of whale migratory routes or increased skittishness of whales due to seismic-survey activities in the Beaufort Sea might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude proposed has not been approached in the region since the 1980s (USDOI, MMS, 2006a; USDOI, BLM and MMS, 1998).

While it is unknown exactly how much of the offshore area would be leased in these future sales, several ship-based exploratory seismic operations have been conducted during the open-water season in 2006 and 2007, resulting in conflicts with marine mammal hunters, and concerns over the fall whaling harvest. Should offshore activity lead to a considerable decrease in success in fall whaling, it would contribute to major negative effects to the North Slope Iñupiat peoples' identity and could have culturewide effects that also would lead to disproportionate high adverse EJ impacts (USDOI, BLM and MMS, 1998).

Onshore, continuing oil and gas leasing and development, as well as ongoing changes in the arctic climate, will have impacts on Iñupiat sociocultural systems in the foreseeable future. Development is currently being considered for the Northeast NPR-A, the planning area for Alpine Field Satellites

development, and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development. This problem could be exacerbated if gas development caused development to extend into the foothills of the Brooks Range. Cumulative effects could include changes to social organization, and impacts to cultural values and general community welfare (e.g., health and education). Changes to social organization potentially could occur as a result of changes in population, employment, subsistence-harvest patterns, social bonds, and cultural values. In addition, the increase in income in NSB communities potentially could result in an increase in social problems, such as drug and alcohol abuse and violence, as well as increasing conflicts from wealth disparities. Social change of this nature would represent disproportionate high adverse EJ impacts (USDOJ, BLM, 2005). Overall, long-term economic, employment, and demographic effects associated with oil and gas leasing and development, particularly onshore, would be expected to be major.

Overall, cumulative impacts to the sociocultural characteristics of North Slope communities could lead to changes to community structure, cultural values, and community health and welfare—changes that actually predate oil and gas development on the North Slope. However, change in community sociocultural characteristics has continued during the period of oil development. As the area impacted by oil development in the future increases, especially in proximity to local communities, cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atkasuk are currently dependent on subsistence caribou harvest from the CAH and TCH; additional future development may have additive impacts to subsistence harvest from these caribou herds, leading to synergistic impacts on subsistence-harvest patterns (including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources), social bonds, and cultural values (USDOJ, BLM, 2004; USDOJ, MMS, 2006b).

Onshore, the abandonment of oil fields and the related loss of revenue no doubt would have serious effects on the entire State of Alaska. However, the collapse of commercial enterprise is seen as inevitable and is common over the history of the Iñupiat. Commercial whaling served the same markets as petrochemicals do today, and the Iñupiat survived by returning to the land. Fur trapping collapsed and the Iñupiat people adapted. Based on this historic demonstration of their resiliency, it would appear that the Iñupiat may be at less risk from the decline of industry than they are in the face of an expanding and unchecked industry. Nevertheless, worldwide data suggest a consistent pattern of marked increases in stress, social problems, and emigration under circumstances of sudden or severe economic depression. Data from Iñupiat populations has shown that economic depression correlates strongly with epidemic rates of suicide (Travis, 1985). In the event of oil field abandonment, the Iñupiat likely would be employed to assist in the removal and demobilization of the infrastructure, while at the same time continuing their subsistence pursuits (USDOJ, BLM, 2005).

Additionally, areas of importance to subsistence users, including areas surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, could be impacted by oil and gas activities and could increase anxiety in Nuiqsut, Barrow, and Atkasuk (USDOJ, BLM, 2005).

We may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The NSB already is experiencing problems in the social health and well-being of its communities, and additional development, including offshore oil development on the North Slope, would further disrupt them. Health and social-services' programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and NSB city governments cannot help

as much now that they get less money from the State. Based on experiences after the EVOS, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs (USDOJ, MMS, 2006b).

Not all sociocultural changes are negative. It is anticipated that there will be a doubling of the population on the North Slope by the year 2040. As long as core Iñupiat values continue to be passed from generation to generation, as they currently are, an increase in the Iñupiat population results in a strengthening of the culture as a whole. At the same time, revenues from NSB taxation on oil development produce positive impacts come from higher incomes, better health care, improved housing, and improved infrastructure and educational facilities, although these impacts may benefit primarily younger individuals who are generally more accepting of change (NRC, 2003a). Iñupiat culture as an adaptive mechanism is a powerful means of self-directed social, political, and cultural change capable of sustaining the Iñupiat through adverse circumstances, as it has for centuries guided them through resource shortages, inter- and intragroup social conflicts, and environmental changes (USDOJ, BLM, 2005).

Health issues caused by persistent and short-term pollution could shorten lifespans of elders, who are the key repositories of traditional and cultural knowledge in the communities. Health issues from increased injuries as a result of the need to travel further over rough terrain to support families with subsistence foods could reduce community involvement with employment, tax the community health infrastructure, encourage outmigration, and lead to increases in substance abuse and depression in those no longer able to participate in subsistence activities. Cuts in funding for services would increase the severity of the problem of delivery of health services, as well as maintaining health and hygiene infrastructure (e.g., fresh water, sewers, and washeteria) (USDOJ, MMS, 2006b). See also the human health discussion in the EJ analysis in Sections 4.4.1.15.

Any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. Although onshore and offshore cumulative effects are difficult to separate, most cumulative effects are thought to result from onshore development. To date, no comprehensive onshore monitoring or baseline data gathering has ever been undertaken. The most obvious cumulative effects have occurred and continue to occur onshore, as oil-field development expands westward from the initial Prudhoe Bay/Deadhorse area of development. Proposed and ongoing studies that will contribute to a more comprehensive understanding of cumulative and human health effects to the Native population of the North Slope are discussed in the EJ cumulative effects analysis in Section 4.4.1.15.8.

Conclusion. Cumulative effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, and Atkasuk could come from disturbance from on-and offshore exploration, development and production activities; small changes in population and employment; and disruption of subsistence-harvest patterns from seismic noise disturbance, oil spills and oil-spill cleanup, and climate change. Accompanying changes to subsistence-harvest patterns, social bonds, and cultural values would be expected to disrupt community activities and traditional practices for harvesting, sharing, and processing subsistence resources, but such changes would not be expected to displace sociocultural institutions (family, polity, economics, education, and religion); social organization; or sociocultural systems (USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2006b). However, if a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (USDOJ, MMS, 2003a, 2006b; USDOJ, BLM and MMS, 2003). Public health effects associated with subsistence impacts would include: (1) an undermining of the protective aspects of the culture and social structure provided by subsistence, and an accompanying incremental contribution to already elevated rates of social and psychological health problems; (2) challenges to food security that could increase even with a major exploration proposal; (3) reduction in the harvest of one or more resources for

more than one season that could contribute to nutritional deficiencies; and, (4) increased accidents and injuries if subsistence hunters are forced to travel longer distances to contact resources, or if whales exhibited less predictable or more agitated behavior because of disturbances from oil and gas activities, making them more difficult to hunt.

Cumulative effects discussed above would be expected to impact EJ to the extent they adversely impacted subsistence resources and harvest practices, sociocultural systems, and public health.

In this cumulative analysis, the level of effects would increase because collectively, activities would be more intense. More air traffic and non-Natives in the North Slope region could increase interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow, Atkasuk, and Kaktovik (USDOI, MMS, 2003a).

Effects from anticipated 3D seismic surveys and exploration should not exceed moderate effects levels with the application of mitigation measures, especially Stipulation 5 that provides for an Adaptive Management Mitigation Plan that reduces potential conflicts between oil industry activities and subsistence whalers. For 3D and 2D seismic surveys and exploration, which are projected to occur for at least 3 years, effects to sociocultural systems are expected to be moderate. Effects to social well being (social systems) could be noticeable because of concern over deflection of the bowhead whale due to seismic survey activities and the attendant effects on subsistence harvests. These concerns may translate into greater activity as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If deflection actually occurred, effects could be major.

At the regional level, offshore effects to sociocultural systems from routine activities from exploration, development and production, and decommissioning (abandonment), would cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level—a moderate effect. At the local level, effects from routine development could exceed a major level of effect. Additionally, effects from a large oil spill would exceed a major level of effect, because noticeable disruption in excess of 2 years could occur from a large spill when combined with cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns. State and Federal mitigation measures should prove effective in ameliorating many of the cumulative effect discussed. Social systems will successfully respond and adapt to the change brought about by the introduction of these activities. If development and production occur, the accommodation response in itself could represent a major impact to social systems. Disproportionate high adverse environmental and health effects on subsistence-based Alaska Native coastal communities in the Beaufort Sea region—major environmental justice effects—are expected to occur only in the event of a large oil spill.

On and offshore, as the area impacted by oil development in the future increases, especially in proximity to local communities; cumulative impacts are likely to increase. For example, Nuiqsut, Barrow, and Atkasuk currently depend on subsistence caribou harvest from the CAH and TLH caribou herds; additional future development may have additive impacts to subsistence harvest from these herds leading to synergistic impacts on subsistence-harvest patterns, including disruption of community activities and traditional practices for harvesting, sharing, and processing subsistence resources; social bonds; and cultural values. If oil and gas development occurs near the north shore of Teshekpuk Lake, and is connected by roads and pipelines to the Alpine field, an important subsistence use area used by residents

of Nuiqsut, Barrow, and Atkasuk could be avoided by subsistence users. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment (USDOI, BLM, 2004; USDOI, BLM and MMS, 1998). Overall, impacts on subsistence harvests and uses would arise from impacts on the availability of subsistence species in traditional use areas or a decrease in subsistence hunting success. The reduction in subsistence hunting success in turn reduces the availability of Native foods to the community. Since the Native community is the only community that depends to a significant degree on Native foods, this impact, to the extent that it occurs, falls disproportionately on the Native population. Onshore, this level of subsistence and social disruption and associated public health concerns would represent disproportionate high adverse EJ effects.

Industrialization clearly displaces subsistence users from traditional use areas even if no legal impediments to access are imposed (NSB, 2003). Essentially, potential effects include disturbance of traditional use and archaeological sites, such as hunting, fishing, and whaling camps, by construction and the increased possibility for vandalism. Any effects to these resources would have a corresponding and proportional effect on cultural value. If development occurred in areas containing concentrations of subsistence cabins, camps, and traditional use sites and subsistence resources experienced only minor impacts, subsistence users would be displaced and impacts would be expected to be far greater. The BLM expects its subsistence stipulations to mitigate potential exploration and development conflicts with subsistence cabins, camps, and use sites (USDOI, BLM and MMS, 2003; USDOI, MMS, 2007d).

If a large spill contacted and extensively oiled coastal habitat, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Such impacts would be considered major. All subsistence-whaling communities and other communities that trade for and receive whale products and other resources from the whaling communities could be affected. A large spill anywhere within the habitat of bowhead whales or other important marine mammal subsistence resources could have multiyear impacts on the harvest of these species by all communities that use them. In the event of a large oil spill, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated. In addition, harvests could be affected by the IWC, which could decide to limit harvest quotas in response to a perceived threat to the bowhead whale population (USDOI, MMS, 2003a, 2006b; USDOI, BLM and MMS, 2003). Such major sociocultural impacts would have a tendency to displace existing social patterns and would represent disproportionate high adverse EJ impacts on subsistence-based Alaskan Native coastal communities in the region.

Beyond the impacts of a large spill, long-term deflection of whale migratory routes or increased skittishness of whales due to increasing seismic surveys and industrialization in the Beaufort Sea would make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated, although a predominant concern continues to be potential disruption associated from seismic survey noise on subsistence-harvest patterns, particularly on the bowhead whale—a pivotal species to the Inupiat culture. Such disruptions would impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Such disruptions could seriously curtail community activities and traditional practices for harvesting, sharing,

and processing subsistence resources—a major impact on sociocultural systems. Such sociocultural impacts would represent major EJ impacts, as well (USDOl, MMS, 2006a).

Onshore, because Nuiqsut is relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community—a major effect; however, overall effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. This same potential exists for the communities of Barrow, Atqasuk, and Kaktovik as Beaufort Sea areawide leasing, exploration, and development proceeds on- and offshore. Any potential effects to subsistence resources and harvest practices and sociocultural systems and consequent impacts on EJ are expected to be mitigated substantially, though not eliminated (USDOl, MMS, 2003a, 2004, 2006b).

Because of impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and, considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, North Slope peoples would experience cultural stresses, as well as impacts to population, employment, and local infrastructure. The termination of oil activity could result in the outmigration of non-Inupiat people from the North Slope, along with some Inupiat who may depend on higher levels of medical support or other infrastructure and services than may be available in a fiscally constrained, post-oil production environment. If subsistence livelihoods are disrupted, Inupiat communities could face increased poverty, drug and alcohol abuse, and other social and public health problems, resulting from a loss of relationship to subsistence resources, the inability to support a productive family unit, and a dependence on non-subsistence foods (Langdon, 1995, Peterson and Johnson, 1995, National Assessment Synthesis Team, 2000, IPCC, 2001).

As stated by Parson et al. (2001): “It is possible that projected climate change will overwhelm the available responses.” It also is realistic to expect that some general assistance could be found to mitigate the losses of nutrition, public health, and income from diminished subsistence resources, but such assistance likely would have little effect in mitigating the associated social and cultural impacts. If present rates of climate change continue, impacts to subsistence resources and harvest practices, sociocultural systems, and public health—and consequent impacts on EJ—would be expected to be major (USDOl, MMS, 2006b, 2007d).

Furthermore, potential long-term impacts on human health from contaminants in subsistence foods and ongoing and increasing social pathologies due to increasing development activities both on- and offshore would be expected to exacerbate overall potential effects on low-income, minority populations (USDOl, MMS, 2006b, 2007d).

4.4.3. Alternative 3, Beaufort Sea Barrow Deferral.

This alternative was developed by MMS in response to scoping comments received in Barrow. This alternative was developed to reduce potential conflicts between bowhead whale subsistence hunters and offshore oil and gas operations. This alternative would offer for lease all of the area described for Beaufort Sea Alternative 2, except for an area located offshore Barrow. The proposed deferral area adjoins an area that the State of Alaska has deferred in recent State sales. This alternative would offer for lease approximately 33,126,710 acres (about 13.4 million hectares), minus any blocks currently leased at the time of the sale. The area deferred under this alternative consists of 15 whole or partial blocks, approximately 67,757 acres (about 27,400 hectares), which is about 0.2% of the Proposed Action area. This alternative would result in a reduction of 1% of the commercial resource potential from the Proposed Action.

4.4.3.1. Water Quality. Alternative 3 would not significantly reduce the estimated oil resource or the activities associated with exploration and development and production. Therefore, this alternative does not substantially lessen the effects on Beaufort Sea water quality for any of the activities discussed in Section 4.4.2.1. There would be some reduction of the local impacts within any deferred area from construction and permitted discharges, but the chance of effects from oil spills to the deferred area would be unaffected.

Conclusion. The effects under Alternative 3 are expected to be minor on local water quality and negligible on regional water quality, the same as for the proposed action.

4.4.3.2. Air Quality. Effects to air quality under Alternative 3 would be the same as those under Alternative 2, the Proposed Action.

4.4.3.3. Lower Trophic-Level Organisms. As explained in Sections 3.3.1 and 4.4.2.3, planktonic habitats that are productive and usually grazed by bowhead whales are located along the coast to the east of Barrow. The area corresponds to ERA44 (Barrow; Appendix A.1, Maps A1-2a and 2c). The OSRA model estimates a <0.5-24% chance of a large spill from any launch area contacting the ERA44 within 30 days during summer (Appendix A.2, Table A.2-5). Without the launch area in the Barrow deferral, the chance of a large spill contacting is similar. The OSRA model estimates a <0.5-15% chance of a large spill contacting from other launch areas, and the Barrow deferral might be leased during a subsequent sale. Therefore, the relatively small Barrow Deferral would not alter the level of effects on lower trophic-level organisms due to disturbance, discharges, or oil spills.

Three aspects of the proposed lease sales that might affect the organisms are physical disturbance, discharges, and spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting up to a thousand acres of typical benthic organisms on the inner Beaufort shelf. The benthic organisms likely would recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later; some assessments might need more accurate information on recolonization and coastal erosion rates.

Standard restrictions of exploratory discharges in shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that the discharge and reinjection practice would continue; however, any discharge proposals would be reviewed by MMS and EPA.

The OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring over a 20-year production life of any field (see Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup would present substantial challenges (Section 4.3.3.1.7). The OSRA model estimates that there is a <0.5-39% chance of a large spill contacting the U.S. Beaufort coastline within 10 days during summer, but that the maximum chance is 18% for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If such a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. Organisms that inhabit these areas probably would experience larger and longer term effects than pelagic or benthic organisms.

The Barrow Deferral is adjacent to an area of high plankton production (Section 3.3.1). Moderation of effects on this area could be achieved by an alternative to the deferral—by the discontinuation of leasing incentives in the Barrow Deferral. The rationale for leasing incentives is summarized in Section 4.1.2; it is partly to encourage additional industry activities in remote areas, leading to commercial production. So, the exclusion of leasing incentives from the Barrow Deferral area would allow the previous rate of development to continue.

Conclusion: Effects on Selecting Alternative 3 on Lower Trophic-level Organisms. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a benefit to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of ongoing climate change, would be major. The extent to which this deferral reduces impacts to lower trophics as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.4. Fish Resources.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to fish resources, because fish resources and fish habitat in the immediate deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate fish resources from certain activities, however, the anticipated environmental consequences to fish resources would be similar to those determined under Alternative 2.

4.4.3.4.1. Potential Effects to Fish Resources. The potential effects to fish resources in the Beaufort Sea were described in Section 4.4.1.4.1 and are not repeated here.

4.4.3.4.2. Mitigation Measures. The potential effects can be moderated by application of the relevant mitigation measures and lease stipulations listed in Section 4.4.2.4.2.

4.4.3.4.3. Anticipated Effects Under Alternative 3. This deferral area would reduce the size of the lease-sale area but was not specifically designed to minimize adverse effects to fish resources. This deferral could serve to protect fish resources and fish habitat in the immediate deferral area from potentially injurious activities associated with oil and gas exploration and development. Deferral areas commonly are associated with nearby communities and traditional subsistence-use areas. This nearshore deferral could serve to delay the time it would take for a large oil spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall impact to fish resources. Because of the small degree to which this alternative would separate fish resources from certain activities, the anticipated environmental consequences to fish resources would be similar to those determined under Alternative 2. The extent to which this deferral reduces impacts to fish resources as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.5. Essential Fish Habitat.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to EFH, because EFH in the immediate area of the deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate EFH from certain activities, the anticipated environmental consequences to EFH would be similar to those determined under Alternative 2.

4.4.3.5.1. Potential Effects to Essential Fish Habitat. The potential effects to EFH in the Beaufort Sea lease-sale area were described in Section 4.4.1.5.1 and are not repeated here.

4.4.3.5.2. Mitigation Measures. The potential effects can be moderated by application of the mitigation measure listed in Section 4.4.2.5.2.

4.4.3.5.3. Anticipated Effects Under Alternative 3. This deferral would reduce the size of the lease-sale area. The deferral was not specifically designed to minimize adverse effects to EFH. This deferral could serve to protect EFH in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. Deferral areas commonly are associated with nearby communities and traditional subsistence-use areas. This nearshore deferral could serve to delay the time it would take for a large oil spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall effects on EFH. The extent to which this deferral reduces impacts to essential fish habitat as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.6. Threatened and Endangered Species.

4.4.3.6.1. Threatened and Endangered Whales.

Summary. The direct, indirect and cumulative adverse effects of this alternative may slightly improve over those noted under Alternative 2, the Proposed Action (Section 4.4.2.6.1), but reductions in impacts are not substantial and effects are considered to be the same (negligible to minor). The ESA-listed whales that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning areas are the bowhead whale, fin whale, and humpback whale; however, current evidence indicates fin whales do not occur in the Beaufort Sea Planning Area.

After reviewing the current status of endangered bowhead, fin, and humpback whales, the environmental baseline for the action area, the proposed action, and the cumulative effects, it is NMFS's biological opinion that individual bowhead, fin, and humpback whales within the action area may be adversely effected, but that the proposed action is not likely to jeopardize the continued existence of Western Arctic Bowhead whales, North Pacific fin whales, or humpback whales. No critical habitat has been designated for these species: therefore, none will be affected. The NMFS concludes at this time, there is reasonable likelihood that oil and gas development and production in the Alaska Beaufort and Chukchi seas, as described, would not violate Section 7(a)(2) of the ESA (NMFS, 2008c).

The following analysis describes potential adverse effects to endangered whales from OCS activities associated with oil and gas exploration and development, described in Section 2.4.4, Scenario for the "Typical" Beaufort Sea Lease Sale (Sales 209 and 217). Anticipated effects discussed herein consider mitigation measures applied to determine the effects under Alternative 3, Barrow Deferral, to bowhead, fin, and humpback whales. The important differences between the Proposed Action (Alternative 2) and this alternative also are addressed.

4.4.3.6.1.2. Potential Effects to Threatened and Endangered Whales. Potential effects to endangered whales were described in Section 4.4.1.6.1.1 and apply to activities identified under Alternative 3, the Barrow Deferral, that could occur if the entire Beaufort Sea Planning Area except for the Barrow Deferral area would be open to proposed Lease Sales 209 and 217. Potential effects described in 4.4.1.6.1.1 remain identical for all alternatives, including the Barrow Deferral, and are not repeated here.

4.4.3.6.1.3. Mitigation Measures. The mitigation measures listed in Section 4.4.2.6.1.2 are applied, as appropriate, to OCS activities to protect ESA-listed whales and other marine mammals during Federal seismic and exploratory drilling in the Beaufort Sea and Chukchi seas. It is anticipated these mitigation measures would be implemented in future activities associated with all alternatives for Lease Sales 209 and 217.

4.4.3.6.1.4. Anticipated Effects Under Alternative 3. This section describes the most important differences in the anticipated effects between the Proposed Action (Alternative 2) and the Barrow Deferral (Alternative 3). Anticipated effects consider mitigation measures and specific biological and activity characteristics discussed in Section 4.4.2.6.1.2.

Conclusions: Effects Under Alternative 3 to Endangered Whales.

4.4.3.6.1.4.1. Direct and Indirect Effects Under Alternative 3.

Summary. This deferral would reduce impacts to bowhead whales during the spring and fall migration periods and summer and fall feeding aggregations of bowhead and humpback whales. However, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing, but it does protect key areas where known feeding concentrations have been documented. Potential displacement from important prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified under this deferral. This deferral further would buffer the contiguous areas west of the deferral by increasing the distance (effectively decreasing exposure to high noise levels) between potential activities on OCS lease blocks to the east. The effects analysis and conclusions are slightly improved. The effects under this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of the Proposed Action, but effects are considered to be the same as under Alternative 2.

This alternative defers 13 full or partial lease blocks near Barrow from the proposed Beaufort Sea sale area (Figure 2-1). The primary reduction in impacts of this deferral would be to exclude disturbance and collision impacts to endangered whales arising from exploration activities in these blocks for the remainder of the present 5-Year Program. These sources of potential adverse effects would occur farther away from a small portion of important migration and feeding habitats. While development is considered speculative, the increased distance between potential offshore launch areas and whale habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill-response time. Any OCS-related infrastructure (pipelines) to transport product still could occur on these blocks, and potential for petroleum spills from these and vessel fuel spills still could occur.

4.4.3.6.1.4.2. Cumulative Effects Under Alternative 3.

Summary. Cumulative effects under Alternative 3 are considered to be the same as under Alternative 2. The extent to which this deferral reduces impacts to endangered whales as compared to Alternative 2, the Proposed Action, would be negligible.

The Barrow Deferral would reduce impacts to endangered whales during the bowhead migration periods and period of concentrated summer-fall feeding; however, its small size limits those reductions in impacts and the effects analysis and conclusions are only slightly improved compared to those for Alternative 2. The Barrow Deferral would not allow oil- and gas-related activities during periods when endangered whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level slightly reduces the total cumulative effect. Impacts to endangered whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a negative, moderate level of effect on whales. The greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on endangered whales in the Beaufort and Chukchi seas. Climate change is likely to continue and although speculative and unpredictable at this time, effects may be positive and/or adverse to endangered whales or their habitat in the Beaufort Sea.

4.4.3.6.2. Threatened and Endangered Birds.

Summary. This deferral would reduce the size of the lease-sale area by excluding an area used by threatened eiders during the postbreeding period; however, its small size limits reductions in impacts to eiders. The level of adverse effect is only slightly reduced compared to Alternative 2. The effects under this alternative are considered to be the same as under Alternative 2.

This alternative would defer 15 full or partial lease blocks near Barrow from the proposed Beaufort Sea sale area (Figure 2-1). In this section, we address the most important differences between this alternative and the Proposed Action (Alternative 2).

4.4.3.6.2.1. Potential Effects to Threatened and Endangered Birds. The potential effects are the same as those described in Section 4.4.1.6.2.1.

4.4.3.6.2.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.3.6.2.3. Anticipated Effects Under Alternative 3. This analysis identifies the anticipated level of effect for this alternative to threatened and endangered birds. The effects of implementing this alternative are separated into the direct and indirect effects (Section 4.4.3.6.2.3.1) and cumulative effects (Section 4.4.3.6.2.3.2).

4.4.3.6.2.3.1. Direct and Indirect Effects Under Alternative 3. This deferral would reduce the size of the lease sale area by excluding an area used by threatened eiders during the postbreeding period; however, its small size limits reductions in impacts to eiders. The change in effect resulting from this deferral for spectacled and Steller's eiders (threatened species) and Kittlitz's murrelet (a candidate species, should it ever be documented to occur in the Beaufort Sea) would be to exclude disturbance and collision impacts to birds arising from exploration drilling in these blocks for the remainder of the 5-Year Program period. These sources of potential adverse effects would occur farther away from important coastal bird habitats, particularly eider-staging and broodrearing areas. While development is considered speculative, the increased distance between offshore development and coastal bird habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill response time. Habitat alterations and surface developments still could occur in adjacent areas. The level of effect is only slightly improved compared to Alternative 2. The effects under this alternative are considered to be the same as under Alternative 2.

4.4.3.6.2.3.2. Cumulative Effects Under Alternative 3. As explained in Section 4.4.3.6.2.3.1, Direct and Indirect Effects under Alternative 3, the Barrow Deferral would reduce impacts to threatened eiders during the postbreeding period; however, its small size limits those reductions in impacts and the adverse effects are only slightly reduced compared to those under Alternative 2. The reduced impact level slightly reduces the total cumulative effect. Impacts to marine and coastal birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic (all unrelated to OCS leasing activities) would continue to have a negative, moderate level of effect on marine and coastal birds. The greatest source of large, noncrude oil spills would continue to arise from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase dramatically the potential for marine accidents and large fuel spills, which could result in a major level of adverse effect on marine and coastal bird populations in the Beaufort Sea. Continued climate change is likely to result in major effects to threatened and endangered birds. The cumulative effects under this alternative are considered to be the same as under Alternative 2. The extent to which this deferral reduces impacts to threatened and endangered birds as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.6.3 Polar Bear.

4.4.3.6.3.1 Conclusions: Effects Under Alternative 3 to Polar Bears. Alternative 3 may slightly reduce adverse impacts to polar bears in comparison to Alternative 2, but the small size of the deferral limits its usefulness. The primary change for polar bears of selecting this deferral would be to defer a small amount of seal habitat that may be used by foraging polar bears. This deferral would not substantially alter the effects determination from that under the Proposed Action, Alternative 2.

4.4.3.6.3.2. Direct and Indirect Effects Under Alternative 3. This deferral would remove approximately 12 mi² from the lease sale. The direct effect of this alternative is the protection of a small amount of polar bear habitat, but this is expected to have negligible reductions in impacts to polar bears. Indirectly, this alternative also would protect a small amount of seal habitat, the primary prey of the polar bear. If deferred, this area would be protected from habitat alteration due to production activities. It also would provide a buffer between potential development activities, and the associated chance of oil spill

contact, and the area between Point Barrow and Dease Inlet. This includes barrier islands occasionally used for den sites. This added buffer potentially could afford additional time for cleanup workers to respond to a spill before it reaches the shoreline. However, the chance of a large spill reaching the shoreline is very small (<1%), regardless of the deferral.

4.4.3.6.3.3. Cumulative Effects Under Alternative 3. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects. The extent to which this deferral reduces impacts to polar bears as compared to Alternative 2, the Proposed Action, would be minor.

4.4.3.7. Marine and Coastal Birds.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and small size only slightly reduces the adverse effects compared to Alternative 2. The level of effects under this alternative are considered to be the same as under Alternative 2.

This alternative would defer 15 full or partial lease blocks near Barrow from the proposed Beaufort Sea sale area (Figure 2-1). In this section, we address the most important differences between this alternative and the Proposed Action (Alternative 2).

4.4.3.7.1. Potential Effects to Marine and Coastal Birds. The potential effects are the same as those described in Section 4.4.1.6.2.1.

4.4.3.7.2. Mitigation Measures. Mitigation measures are the same as those identified in Section 4.4.2.6.2.2.

4.4.3.7.3. Anticipated Effects Under Alternative 3. This analysis identifies the anticipated level of effect under this alternative to marine and coastal birds. These effects are separated into the direct and indirect effects (Section 4.4.3.7.3.1) and the cumulative effects (Section 4.4.3.7.3.2) of implementing this alternative.

4.4.3.7.3.1. Direct and Indirect Effects Under Alternative 3. This deferral reduces the size of the lease-sale area. This reduction in size would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and small size only slightly reduces the adverse effects compared to Alternative 2. The level of effects under this alternative are considered to be the same as under Alternative 2.

The primary difference of this deferral for marine and coastal birds would be to exclude disturbance and collision impacts to birds arising from exploration drilling in these blocks for the remainder of the 5-Year Program period. These sources of potential adverse effects would occur farther away from important coastal bird habitats, particularly staging, migrating, and broodrearing areas. While development is considered speculative, the increased distance between offshore development and coastal bird habitats would conceivably decrease the percent chance of a large spill contacting important bird habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time. Habitat alterations and surface developments could still occur in adjacent areas.

4.4.3.7.3.2. Cumulative Effects Under Alternative 3. As explained in Section 4.4.3.7.3.1, the Barrow Deferral could reduce adverse effects to marine and coastal birds during the open-water period;

however, its location and small size only slightly reduces adverse effects compared to those under Alternative 2. The reduced impact level slightly reduces the total cumulative effect. Impacts to marine and coastal birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic—all unrelated to OCS leasing activities—would continue to have a negative, moderate level of effect on marine and coastal birds. The greatest source of large noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in a major level of adverse effect on marine and coastal bird populations in the Beaufort Sea. Continued climate change is likely to result in a major level of effect to marine and coastal birds. The cumulative effects under this alternative are considered to be the same as under Alternative 2. The extent to which this deferral reduces impacts to marine and coastal birds as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.8. Other Marine Mammals. This alternative would offer about 6,108 whole or partial lease blocks in the lease sale area (Figure 2-1). The following analyses describe the anticipated effects under Alternative 3, the Barrow Deferral, on marine mammals of the Alaskan Beaufort Sea. The Barrow Deferral constitutes about 0.2% of the Beaufort Sea lease-sale area.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects under Alternative 3 versus Alternative 2 are the same for ice seals. Considering that the Barrow Deferral constitutes about 0.2% of the Beaufort Sea lease sale area, the effects to ice seals under this alternative would be similar to those under Alternative 2.

Pacific Walrus. When compared with Alternative 2, Alternative 3 may slightly decrease impacts to walrus, but the small size of the deferral limits its usefulness. The primary effect to walrus under Alternative 3 would be to protect a small amount of habitat that may reduce impacts to foraging walrus. The deferral occurs in the westernmost edge of the planning area, the area most likely to have walrus regularly in summer. The selection of this deferral would not substantially alter the effects determination (a negligible or minor level of effect) from that of the Alternative 2, the Proposed action.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. Adverse effects under this alternative may be slightly reduced compared to those under Alternative 2, the Proposed Action but the reductions are not substantial, and direct, indirect, and cumulative effects are considered to be the same as under Alternative 2 (a negligible to minor level of effect).

4.4.3.8.1. Potential Effects to Marine Mammals. The potential effects from a number of activities in the Arctic to marine mammals in the Beaufort Sea are described in Section 4.4.1.8.1. Potential effects specific to whales that also may apply to minke and gray whales are described in Section 4.4.1.6.1.1.

4.4.3.8.2. Mitigation Measures. The potential effects may be moderated by the mitigation measures identified in Section 4.4.2.8.2.

4.4.3.8.3. Anticipated Effects Under Alternative 3. In this section, we determine the anticipated level of effect under Alternative 3 to marine mammals in the Alaskan Beaufort Sea. These anticipated effects consider mitigation measures described above. We defined the terms used to describe the anticipated level of effect in Section 4.4.1.8.3. The anticipated effects of implementing this alternative

are separated into direct and indirect effects (Section 4.4.3.8.3.1) and cumulative effects (Section 4.4.3.8.3.2).

4.4.3.8.3.1. Direct and Indirect Effects under Alternative 3

Ringed, Spotted, Ribbon, and Bearded Seals. The Barrow Deferral could slightly lessen the cumulative chance of disturbances occurring. However this deferral can be expected to result in added scrutiny of the leased areas through reallocation of resources, leading to a level of effects similar to those described in 4.4.2.8.3.1 for the Alaskan Beaufort Sea. Consequently the expected direct and indirect effects on ice seals are similar to those described in Section 4.4.2.8.3.1.

Pacific Walrus. The direct effect of this alternative is the protection of a small amount of walrus foraging habitat. If deferred, this area would be protected from habitat alteration. Indirectly, it also would provide a buffer between potential development activities, and the associated chance of oil spill contact. This added buffer potentially could afford additional time for cleanup workers to respond to a spill before it reaches the spring lead system in the Barrow area.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. This deferral would slightly reduce adverse effects to grey and beluga whales during the spring and fall migration periods and feeding aggregations. However, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing, but it does protect key areas where known feeding concentrations have been documented. Potential displacement from important prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. This deferral would further buffer the contiguous areas west of the deferral by increasing the distance (effectively decreasing exposure to high noise levels) between potential activities on OCS lease blocks to the east. The effects of this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of any new leases, but the direct and indirect effects are considered to be the same as those under Alternative 2.

This deferral would exclude disturbance and collision impacts to nonendangered whales arising from exploration activities in the deferral for the remainder of the present 5-Year Program. These sources of potential adverse effects would occur farther away from a small portion of important migration and feeding habitats. While development is considered speculative, the increased distance between potential offshore launch areas and whale habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill response time. Any OCS-related infrastructure (pipelines) to transport product still could occur on these blocks, and potential for petroleum spills from pipelines and vessel fuel spills still could occur.

4.4.3.8.3.2. Cumulative Effects Under Alternative 3. Cumulative effects under this alternative result from the combination of the direct and indirect effects (above) and the cumulative effects under Alternative 1.

Ringed, Spotted, Ribbon, and Bearded Seals. Cumulative effects are similar to those described in Section 4.4.2.8.3.2. The extent to which this deferral reduces impacts to seals as compared to Alternative 2, the Proposed Action, would be negligible.

Pacific Walrus. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects. Alternative 3 may provide some minor decrease in

impacts to walrus, but the small size of the deferral limits its usefulness, and it does not change the effects determination from that under Alternative 2 (a negligible level of effect). The primary reduction in impacts to walrus under this deferral would be to protect a small amount of habitat that may see a reduction in impacts to foraging walrus. The extent to which this deferral reduces impacts to walrus as compared to Alternative 2, the Proposed Action, would be negligible.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. The Barrow Deferral would slightly reduce adverse effects to grey whales and belugas during migration periods and periods of concentrated summer-fall feeding; however, its small size limits the reduction and the effects analysis and conclusions are only slightly improved compared to those under Alternative 2. The Barrow Deferral would not allow oil- and gas-related activities during periods when whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level slightly reduces the total cumulative effect. The extent to which this deferral reduces impacts to whales as compared to Alternative 2, the Proposed Action, would be negligible.

Impacts to whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a negative, moderate level of effect on whales. The greatest source of large, noncrude oil spills would continue to arise from bulk-fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on whales in the Beaufort and Chukchi seas. Trends in climate change are likely to continue and, although speculative and unpredictable at this time, effects may be positive and/or adverse to whales or their habitat in the Alaskan Beaufort Sea.

4.4.3.9. Terrestrial Mammals. This alternative would defer 15 whole or partial blocks around Barrow from the proposed Beaufort Sea sale area (Figure 2-1). The following analysis describes the anticipated effects to terrestrial mammals if the lease sale took place with the Barrow subarea deferral in the Beaufort Sea analysis area. Considering the fact that the Barrow Deferral subarea constitutes 0.2% of the Beaufort Sea analysis area, the impacts on terrestrial mammals under this alternative would be similar to those under Alternative 2. In this section, we describe the anticipated effects on terrestrial mammals under the Proposed Action with mitigation measures in place. The effects under Alternative 3 versus Alternative 2 are similar for terrestrial mammals. A complete description of the Proposed Action is located in Section 2.2, while a description of the exploration, and development scenarios are located in Section 2.4.

This analysis identifies the anticipated level of effect for this alternative on terrestrial mammals. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.3.9.3.1) and cumulative effects (Section 4.4.2.9.3.1.6.2).

4.4.3.9.1. Potential Effects to Terrestrial Mammals. Potential effects are described in Section 4.4.1.9.1.

4.4.3.9.2. Mitigation Measures. Mitigation measures are the same as described in Section 4.4.2.9.2.

4.4.3.9.3. Anticipated Effects Under Alternative 3. The anticipated effects under Alternative 3 would be the same as those described in Section 4.4.2.9.3.

4.4.3.9.3.1. Direct and Indirect Effects under Alternative 3. The direct and indirect effects would be the same as those described in Section 4.4.2.9.3.1.

4.4.3.9.3.2. Cumulative Effects Under Alternative 3. Cumulative effects would be the same as those described in Section 4.4.2.9.3.2. The extent to which this deferral reduces impacts to terrestrial mammals as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.10. Vegetation and Wetlands. The effects to vegetation and wetlands under Alternative 3, Barrow Deferral, would be the same as those under Alternative 2, the Proposed Action. The extent to which this deferral reduces impacts to vegetation and wetlands as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.3.11. Economy. There would be no effective difference between the economic effects under Alternative 3, Barrow Deferral, and Alternative 2, the Proposed Action.

4.4.3.12. Subsistence-Harvest Patterns and Resources. This alternative was developed in response to scoping comments received in Barrow. This deferral would reduce potential conflicts between bowhead whale subsistence hunters and offshore oil and gas operations, based on bowhead whale-strike data provided by the Alaska Eskimo Whaling Commission (AEWC), increasing protection to the Barrow subsistence whale hunt and other subsistence activities from potential noise and disturbance from exploration or development and production activities. This alternative would offer for leasing all of the area described under Alternative 2, except for a subarea located in the western portion of the proposed sale area. The majority of the bowhead whale subsistence-hunting area near Barrow includes an area in the Chukchi Sea, which already was removed from leasing in the 2007-2012 5-Year Program.

4.4.3.12.1. Direct and Indirect Effects Under Alternative 3. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. This deferral would move the zone for potential noise, disturbance, and oil-spill effects farther away from Barrow subsistence whaling areas.

Conclusion. Effects on subsistence-harvest patterns are expected to be reduced, because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. The chance of spring bowhead whale encounters with industrial noise likely would be reduced from Alternative 2, the Proposed Action. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. There would be no reduction in effects from potentially permitted seismic surveys onshore or in the sale area.

4.4.3.12.2. Cumulative Effects Under Alternative 3.

Conclusion. Offering a reduced area for leasing would result in a slight reduction in cumulative effects to subsistence resources and harvest patterns under Alternative 3 as compared to Alternative 2, the Proposed Action.

4.4.3.13. Sociocultural Systems.

4.4.3.13.1. Direct and Indirect Effects Under Alternative 3. This deferral would prohibit leasing, exploration, development, and production activities in the deferral area; thus, moving the zone for potential noise, disturbance, and oil-spill effects farther away from subsistence-whaling areas.

Conclusion. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. Effects to sociocultural systems are expected to be reduced under this deferral alternative to the extent they reduce effects to subsistence-harvest patterns. Because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting, effects to sociocultural systems would be reduced accordingly. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas would still cross deferred areas. Effects to sociocultural systems likely would be reduced under Alternative 3 as compared to Alternative 2, the Proposed Action.

4.4.3.12.2. Cumulative Effects Under Alternative 3.

Conclusion. By offering a reduced area for leasing, a slight reduction in adverse cumulative impacts would be expected on subsistence resources and harvest patterns and consequent effects on sociocultural systems under Alternative 3 as compared to Alternative 2, the Proposed Action.

4.4.3.14. Archaeological Resources.

4.4.3.14.1. Direct and Indirect Effects Under Alternative 3. This deferral would prohibit leasing, exploration, development, and production activities on 15 whole or partial blocks off Barrow.

Conclusion. The potential effects under Alternative 3 to archaeological resources are essentially the same as discussed under Alternative 2, the Proposed Action, except the areas deferred would be removed from any bottom-disturbing activities. More potential effects are likely to occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Prehistoric and historic resources both onshore and offshore would be identified by archaeological surveys and avoided or mitigated.

4.4.3.14.2. Cumulative Effects under Alternative 3.

Conclusion. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects on archaeological resources under Alternative 3 from those under Alternative 2, the Proposed Action.

4.4.3.15. Environmental Justice.

Alternative 3 would offer for leasing all of the area described for Alternative 2, except for a subarea located in the western portion of the proposed sale area. The majority of the bowhead whale subsistence-hunting area near Barrow includes an area in the Chukchi Sea, which already was removed from leasing in the 2007-2012 5-Year Program. This alternative was developed in response to scoping comments received in Barrow and would reduce potential conflicts between bowhead whale subsistence hunters and offshore oil and gas operations, based on bowhead whale-strike data provided by the AEWG; thus, increasing protection to the Barrow subsistence whale hunt and other subsistence activities from potential noise and disturbance from exploration or development and production activities. The alternative is intended to reduce effects to subsistence-harvest patterns, because no exploration or production activities would occur in the deferral area.

4.4.3.15.1. Direct and Indirect Effects Under Alternative 3. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. This deferral would prohibit leasing, exploration, development, and production activities in the western portion of the sale area; thus, moving the zone for potential noise, disturbance, discharges, airborne emissions, and oil-spill effects farther away from subsistence whaling areas. Climate change, and economic, employment, and demographic effects would be similar between this Alternative and Alternative 2. By reducing potential subsistence impacts, this Alternative would reduce anticipated public health impacts relative to Alternative 2; this difference would be most evident in Barrow, but also would be important in villages that receive shared subsistence resources from Barrow. As described in Section 4.4.1.15 and subsections (Beaufort Sea, Alternative 1, EJ), subsistence forms the foundation of health in rural Alaskan Native villages. Adverse effects on subsistence can impact general health and well-being, diet and nutrition, injury rates, and rates of nutrition-related chronic diseases such as diabetes, hypertension, and cardiovascular disease.

Conclusion. Effects on EJ are expected to be reduced by this deferral alternative to the extent they reduce effects to subsistence-harvest patterns, sociocultural systems, and associated effects to public health. Because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, other marine mammal hunting, and sociocultural systems, effects to EJ would be reduced accordingly. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. Effects to EJ likely would be reduced under Alternative 3 compared to Alternative 2, the Proposed Action.

4.4.3.15.2. Cumulative Effects Under Alternative 3.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts would be expected. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects on subsistence resources and harvest patterns, sociocultural systems, and subsistence-related health impacts for Barrow and villages with which Barrow shares subsistence resources and, thus, consequent effects to EJ under Alternative 3 compared to Alternative 2, the Proposed Action.

4.4.4. Alternative 4, Beaufort Sea Cross Island Deferral.

This alternative was developed by MMS to address issues identified by the Alaska Eskimo Whaling Commission (AEWC), the Native Village of Nuiqsut, and the NSB related to protecting the Nuiqsut subsistence bowhead whaling area. This alternative was developed to provide protection of the Nuiqsut subsistence bowhead whaling area as defined by known whale-strike data. This alternative would offer for lease all of the area described for Beaufort Sea Alternative 2, except for an area located north and east of Cross Island. This alternative would offer for lease 6,082 whole or partial blocks comprising approximately 32,986,825 acres (about 13.4 million hectares), minus any blocks currently leased at the time of the sale. The area deferred under this alternative consists of 38 whole or partial blocks, approximately 207,641 acres (about 32 thousand hectares), which is about 0.6% of the Proposed Action area. This alternative would result in a reduction of 5% of the commercial resource potential from the Proposed Action.

4.4.4.1. Water Quality. Alternative 4 would not significantly reduce the estimated oil resource or the activities associated with exploration and development and production. Therefore, this alternative does not substantially lessen the effects on Beaufort Sea water quality for any of the activities discussed in Section 4.4.2.1. There would be some reduction of the local impacts within any deferred area from construction and permitted discharges, but the chance of effects from oil spills to the deferred area would be unaffected.

Conclusion. The effects of Alternative 4 are expected to be minor on local water quality and negligible on regional water quality, the same as for the Proposed Action.

4.4.4.2. Air Quality. Effects to air quality under Alternative 4 would be the same as those under Alternative 2, the Proposed Action.

4.4.4.3. Lower Trophic-Level Organisms. The relatively small Cross Island Deferral would not alter the level of effects to lower trophic-level organisms due to disturbance, discharges, or spills. Further, the combination of the Cross Island Deferral with the Barrow (Alternative 3), Eastern (Alternative 5), and/or Deepwater (Alternative 6) Deferrals would not alter the level of effects.

Three aspects of the proposed lease sales that might affect the organisms are physical disturbance, discharges, and spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting up to a thousand acres of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later, some assessments might need more accurate information on recolonization and coastal erosion rates.

Standard restrictions of exploratory discharges into shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that the discharge and reinjection practice would continue; and any discharge proposals would be reviewed by MMS and EPA.

The OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring over a 20-year production life. If the assumed spills occur in broken ice, cleanup would present substantial challenges (Section 4.3.3.1.7). The OSRA model estimates the fate of spills from LA12, which contains the Cross Island Deferral. There is a 13% chance of a large spill from this area contacting the U.S. Beaufort

coastline within 10 days during summer. The OSRA model also estimates a <0.5-39% chance that a summer spill from anywhere in the lease-sale area would contact the Alaskan coastline within 10 days, but that the maximum chance is only 18% for a 3-day trajectory. The difference indicates a reduction in impacts to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If such a large spill contacts the coastline, oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. Organisms that inhabit these areas probably would experience larger and longer term effects than pelagic or benthic organisms.

Conclusion. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a reduction in impacts to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.5). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of ongoing climate change, would be major. The extent to which this deferral reduces impacts to lower trophics as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.4. Fish Resources.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to fish resources, because fish resources and fish habitat in the immediate deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate fish resources from certain activities, the anticipated environmental consequences to fish resources would be similar to those under Alternative 2.

4.4.4.4.1. Potential Effects to Fish Resources. The potential effects to fish resources in the Beaufort Sea were described in Section 4.4.1.4.1 and are not repeated here.

4.4.4.4.2. Mitigation Measures. Potential effects can be moderated by application of the mitigation measures listed in Section 4.4.2.4.2.

4.4.4.4.3. Anticipated Effects Under Alternative 4. This deferral would reduce the size of the lease-sale area, but it was not specifically designed to minimize adverse effects to fish resources. This deferral could serve to protect fish resources and fish habitat in the immediate deferral area from potentially injurious activities associated with oil and gas exploration and development. Deferral areas commonly are associated with nearby communities and traditional subsistence-use areas. This nearshore deferral could serve to delay the time it would take for a large oil spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall impact to fish resources. Because of the small degree to which this alternative would separate fish resources from

certain activities, the anticipated environmental consequences to fish resources under Alternative 4 would be similar to those under Alternative 2. The extent to which this deferral reduces impacts to fish resources as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.5. Essential Fish Habitat.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to EFH, because EFH in the immediate area of the deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate EFH from certain activities, the anticipated environmental consequences to EFH would be similar to those under Alternative 2.

4.4.4.5.1. Potential Effects to Essential Fish Habitat. Potential effects to EFH in the Beaufort Sea were described in Section 4.4.1.5.1 and are not repeated here.

4.4.4.5.2. Mitigation Measures. The effects can be moderated by application of the mitigation measures listed in Section 4.4.2.5.2.

4.4.4.5.3. Anticipated Effects under Alternative 4. This deferral would reduce the size of the lease-sale area. The deferral was not specifically designed to minimize adverse effects to EFH. This deferral could serve to protect EFH in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. Deferral areas are commonly associated with nearby communities and traditional subsistence use areas. This nearshore deferral could serve to delay the time it would take for a large oil spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall effects on EFH. Because of the small degree to which this alternative would separate EFH from certain activities, the anticipated environmental consequences to EFH under Alternative 4 would be similar to those under Alternative 2. The extent to which this deferral reduces impacts to EFH as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.6. Threatened and Endangered Species.

4.4.4.6.1. Threatened and Endangered Whales.

Summary. The direct, indirect, and cumulative effects under Alternative 4 may slightly improve over those under Alternative 2, the Proposed Action (Section 4.4.2.6.1), but reductions in impacts are not substantial, and effects are considered to be the same (negligible to minor) as under Alternative 2. The ESA-listed whales that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning units are the bowhead whale, fin whale, and humpback whale; however, current evidence indicates fin whales do not occur in the Beaufort Sea Planning Area.

After reviewing the current status of bowhead, fin, and humpback whales, the environmental baseline for the action area, the Proposed Action, and the cumulative effects, it is NMFS's biological opinion that individual bowhead, fin, and humpback whales within the action area may be adversely affected, but that the Proposed Action is not likely to jeopardize the continued existence of Western Arctic Bowhead whales, North Pacific fin whales, or humpback whales. No critical habitat has been designated for these species; therefore, none would be affected. The NMFS concludes at this time that there is reasonable

likelihood that oil and gas development and production in the Alaska Beaufort and Chukchi seas, as described, would not violate Section 7(a)(2) of the ESA (NMFS, 2008c).

The following analysis describes potential adverse effects to endangered whales from OCS activities associated with oil and gas exploration and development activities as described in Section 2.4.1, Scenario for the “Typical” Beaufort Sea Lease Sale (Sales 209 and 217). Anticipated effects discussed herein consider mitigation measures applied to potential effects to determine the effects under Alternative 4, the Cross Island Deferral, to bowhead, fin, and humpback whales. In this section, we address the important differences between the Proposed Action (Alternative 2) and Alternative 4.

4.4.4.6.1.1. Potential Effects to Threatened and Endangered Whales. Potential effects to endangered whales were described in Section 4.4.1.6.1.1 and apply to activities identified under Alternative 4, the Cross Island Deferral, that could occur if the entire Beaufort Sea Planning Area, except the Cross Island Deferral area, would be open to proposed Lease Sales 209 and 217. Potential effects described in 4.4.1.6.1.1 remain identical for all alternatives, including the Cross Island Deferral, and are not repeated here.

4.4.4.6.1.2. Mitigation Measures. The mitigation measures listed in Section 4.4.1.6.1.2 are applied, as appropriate, to OCS activities to protect ESA-listed whales and other marine mammals during Federal seismic and exploratory drilling in the Beaufort Sea and Chukchi Sea. It is anticipated these mitigation measures would be implemented in future activities associated with all alternatives for Lease Sale 209 and/or 217, including the Cross Island Deferral.

4.4.4.6.1.3. Anticipated Effects Under Alternative 4. This section describes the most important differences in the anticipated effects between the Proposed Action (Alternative 2) and the Cross Island Deferral (Alternative 4). Anticipated effects consider mitigation measures and specific biological and activity characteristics discussed in Sections 4.4.1.6.1.3 and 4.4.2.6.1.3.

4.4.4.6.1.3.1. Direct and Indirect Effects Under Alternative 4.

Summary. This deferral would reduce impacts to bowhead whales during the fall migration period and fall feeding aggregations; however, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing, but it does protect key areas where known feeding concentrations have been documented. Potential displacement from prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS activities on the lease blocks identified in the deferral. The blocks within the deferral would be buffered by increasing the distance (effectively decreasing exposure to high noise levels) between potential activities on adjacent, active OCS lease blocks. The effects analysis and conclusions are slightly improved. The effects of this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of the Proposed Action and experience lower levels or fewer stress-inducing events, but effects are considered to be the same as under Alternative 2.

This alternative defers 38 full or partial lease blocks around Cross Island from the Beaufort Sea sale area (Figure 2-1). The primary reduction in impacts of this deferral would be to exclude disturbance and collision impacts to endangered whales arising from exploration activities in these blocks for the remainder of the 2007-2012 5-Year Program period. These sources of potential adverse effects would occur farther away from a small portion of important migration and feeding habitats. While development is considered speculative, the elimination of potential lease blocks within the deferral area and increased distance between LA12 and whale habitats conceivably would decrease the percent chance of a large oil spill contacting, increase weathering of spilled oil prior to contact, and increase available spill-response

time before contacting the feeding and migration habitats. Any OCS-related infrastructure (pipelines) still could occur on these blocks, and petroleum spills from them and vessel fuel spills still could occur, as noted in Section 4.4.4.2.6.1.3.8.

4.4.4.6.1.3.2. Cumulative Effects Under Alternative 4.

Summary. The cumulative effects under Alternative 4 are considered to be the same as under Alternative 2.

As explained in Section 4.4.4.6.1.3.1, Direct and Indirect Effects under Alternative 4, the Cross Island Deferral would reduce impacts to endangered whales during the bowhead migration periods and period of concentrated summer-fall feeding; however, its small size limits those reductions in impacts and the effects analysis and conclusions are only slightly improved compared to those under Alternative 2. Alternative 4 would not allow oil- and gas-related activities during periods when endangered whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level slightly reduces the total cumulative effect. Impacts to endangered whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a negative, moderate level of effect on whales. The greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on endangered whales in the Beaufort and Chukchi seas. Climate change is likely to continue, and although speculative and unpredictable at this time, effects may be positive and/or adverse to endangered whales or their habitat in the Beaufort Sea. The extent to which this deferral reduces impacts to endangered whales as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.6.2. Threatened and Endangered Birds.

Summary. This deferral would reduce the size of the lease-sale by excluding an area used by threatened eiders during the postbreeding period; however, its small size and location does little to reduce effects on eiders. This deferral area is further from core nesting areas, and fewer broods or migrating spectacled eiders would be expected to normally use this area. The level of adverse effect is only slightly reduced compared to Alternative 2. The effects under this alternative are considered to be the same as under Alternative 2.

This alternative would defer 38 full or partial lease blocks near Cross Island from the proposed Beaufort Sea sale area (Figure 2-1).

4.4.4.6.2.1. Potential Effects to Threatened and Endangered Birds. Potential effects would be the same as those described in Section 4.4.1.6.2.1.

4.4.4.6.2.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.4.6.2.3. Anticipated Effects Under Alternative 4. This analysis identifies the anticipated level of effect under this alternative to threatened and endangered birds. The effects of implementing this alternative are separated into the direct and indirect effects (Section 4.4.4.6.2.3.1) and the cumulative effects (Section 4.4.4.6.3.2).

4.4.4.6.2.3.1. Direct and Indirect Effects Under Alternative 4. This deferral reduces the size of the lease sale by excluding an area used by threatened eiders during the postbreeding period; however, its small size and location does little to reduce effects to eiders. The change in effect resulting from this deferral for spectacled and Steller's eiders (threatened species) and Kittlitz's murrelet (a candidate species, should it ever be documented to occur in the Beaufort Sea) would be to exclude disturbance and collision impacts to birds arising from exploration drilling in these blocks for the remainder of the 2007-2012 5-Year Program period. These sources of potential adverse effects would occur farther away from important coastal bird habitats, particularly eider staging and broodrearing areas. While development is considered speculative, the increased distance between offshore development and coastal bird habitats conceivably would decrease the percent chance of a large spill contacting, increase weathering of spilled oil prior to contact, and increase available spill response time. Habitat alterations and surface developments still could occur in adjacent areas. The level of adverse effect is only slightly reduced compared to Alternative 2. The effects under this alternative are considered to be the same as under Alternative 2.

4.4.4.6.2.3.2. Cumulative Effects Under Alternative 4. As explained in Section 4.4.4.6.2.3.1, Direct and Indirect Effects under Alternative 4, the Cross Island Deferral would reduce impacts to threatened eiders during the postbreeding period; however, its small size and location limits those reductions in impact, and the adverse effects are only slightly reduced compared to those under Alternative 2. The reduced impact level slightly reduces the total cumulative effect. Impacts to ESA-protected birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic (all unrelated to OCS leasing activities) would continue to have a negative, moderate level of effect on threatened and endangered birds. The greatest source of large noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in a major level of adverse effect on threatened and endangered bird populations in the Beaufort Sea. Continued climate change is likely to result in a major level of effect to threatened and endangered birds.

4.4.4.3.6.3. Polar Bear.

Conclusions. Alternative 4 would reduce slightly the footprint of the proposed lease sale by deferring an area adjacent to known late summer/fall aggregations of polar bears. Although the reduction in impact to polar bears is limited due to the small size of the deferral, deferring habitat from production activities in this increasingly important area could provide moderate protections to polar bears in this area. This deferral would buffer the Cross Island aggregation area, protecting a small amount of seal habitat that may reduce impacts to foraging polar bears, and protecting a small amount of potential polar bear denning habitat. This alternative would improve slightly the effects determination for polar bears.

4.4.4.3.6.3.1. Direct and Indirect Effects Under Alternative 4. This deferral area would remove approximately 30 mi² from the lease sale. The direct effect under this alternative would be the protection of a small amount of polar bear habitat near the Cross Island aggregation area, and providing a buffer to a known denning area. This is expected to have minor reduction in impacts to polar bears. Indirectly, this alternative also would protect a small amount of seal habitat, the primary prey of the polar bear. If deferred, this area would be protected from habitat alteration. In addition, it would provide a small buffer to the northeast between potential development activities, the associated chance of oil spills, and Cross Island. This includes barrier islands occasionally used for den sites. This added buffer potentially could afford additional time for cleanup workers to respond to a spill before it reaches the shoreline. However,

the percent chance of a large spill occurring and reaching the shoreline in this area is very small (<1%), regardless of the deferral.

4.4.4.3.6.3.2. Cumulative Effects Under Alternative 4. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects. Alternative 4 would have a minor effect on the overall level of impacts to polar bears. The extent to which this deferral reduces impacts to polar bears as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.7. Marine and Coastal Birds.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce the adverse effects to marine and coastal birds during the open-water period; however, its location and small size only slightly reduces adverse effects compared to Alternative 2. The level of effects under this alternative is considered to be the same as under Alternative 2.

This alternative would defer approximately 38 full or partial lease blocks, around Cross Island, from the Beaufort Sea sale area (Figure 2-1). In this section, we address the most important differences between this alternative and the Proposed Action (Alternative 2).

4.4.4.7.1. Potential Effects to Marine and Coastal Birds. The potential effects are the same as those described in Section 4.4.1.6.2.1.

4.4.4.7.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.4.7.3. Anticipated Effects Under Alternative 4. This analysis identifies the anticipated level of effect for this alternative on marine and coastal birds. The anticipated effects from implementing this alternative are separated into direct and indirect effects (Section 4.4.4.7.3.1) and cumulative effects (Section 4.4.4.7.3.2).

4.4.4.7.3.1. Direct and Indirect Effects Under Alternative 4. This deferral would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and small size only slightly reduces adverse effects compared to Alternative 2.

The primary difference of this deferral for marine and coastal birds compared to Alternative 2 would be to exclude disturbance and collision impacts to birds arising from exploration drilling in these blocks for the remainder of the 5-Year Program period. These sources of potential adverse effects would occur farther away from important coastal bird habitats, particularly staging, migrating, and broodrearing areas. While development is considered speculative, the increased distance between offshore development and coastal bird habitats conceivably would decrease the percent chance of a large spill contacting, increase weathering of spilled oil prior to contact, and increase available spill-response time. Habitat alterations and surface developments still could occur in adjacent areas. The effects under this alternative are considered to be the same as under Alternative 2.

4.4.4.7.3.2. Cumulative Effects Under Alternative 4. As explained in Section 4.4.4.7.3.1, the Cross Island Deferral would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and small size only slightly reduces adverse effects compared to those under Alternative 2. The reduced impact level slightly reduces the total cumulative effect. Impacts to marine and coastal birds from (1) continued community and oil and gas infrastructure developments, (2)

collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic (all unrelated to OCS leasing activities) would continue to have a negative, moderate level of effect on marine and coastal birds. The greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in a major level of adverse effects on marine and coastal bird populations in the Beaufort Sea. Continued climate change is likely to result in a major level of effect to marine and coastal birds. The extent to which this deferral reduces impacts to marine and coastal birds as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.8. Other Marine Mammals. This alternative would offer about 6,085 whole or partial blocks in the lease-sale area (Figure 2-1). The following analyses describe the anticipated effects under Alternative 4, the Cross Island Deferral, on marine mammals in the Alaska Beaufort Sea. The Cross Island Deferral constitutes about 0.6% of the Beaufort Sea lease sale area.

Ringed, Spotted, Ribbon, and Bearded Seals. The effects under Alternative 4 versus Alternative 2 are the same for northern ice seals. The Cross Island Deferral constitutes 0.6% of the Beaufort Sea analysis area; however, the impacts to ice seals under this alternative would be similar to those under Alternative 2.

Pacific Walrus. The effects under this alternative are the same as under Alternative 2. This alternative would have negligible effects to walrus, because walrus commonly do not use the Cross Island area in large numbers.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. The effects under this alternative may be slightly reduced compared to those under Alternative 2, the Proposed Action, but the reduction is not substantial and effects are considered to be the same (negligible to minor) as under Alternative 2. Baleen whales other than ESA-listed species that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning areas are minke and gray whales; however, current evidence indicates minke whales do not occur in the Beaufort Sea Planning Area. Beluga whales are the only toothed whales known to regularly occur in the Proposed Action area.

4.4.4.8.1. Potential Effects to Marine Mammals. The potential effects for marine mammals in the Beaufort Sea were described in Section 4.4.1.8.1. Potential effects to whales that also may apply to minke and gray whales are described in Section 4.4.1.6.1.1.

4.4.4.8.2. Mitigation Measures. The potential effects may be moderated by the mitigation measures identified in Section 4.4.2.8.2.

4.4.4.8.3. Anticipated Effects Under Alternative 4. In this section, we determine the anticipated level of effect on marine mammals if MMS opens the lease-sale area with the Cross Island Deferral in the Beaufort Sea. These anticipated effects consider mitigation measures described in Section 4.4.2.8.2. We defined the terms used to describe the anticipated level of effect in Section 4.4.1.8.3. The anticipated effects under this alternative are separated into direct and indirect effects (Section 4.4.4.8.3.1) and cumulative effects (Section 4.4.4.8.3.2).

4.4.4.8.3.1. Direct and Indirect Effects Under Alternative 4.

Ringed, Spotted, Ribbon, and Bearded Seals. Deferring the area around Cross Island from leasing could slightly lessen the indirect chance of disturbances occurring. However this deferral can be expected to result in added scrutiny of the leased areas through reallocation of resources, leading to a level of effects similar to those described in 4.4.2.8.3.1. Consequently, the expected direct and indirect effects to ice seals are similar to those described in Section 4.4.2.8.3.1.

Pacific Walrus. The direct effects under this alternative would be to defer roughly 30 mi² from the lease sale. This would decrease slightly the overall footprint of the lease sale. Indirectly, this could protect a small amount of habitat from alteration. This alternative would have a negligible level of effect on walrus. Walrus commonly do not use this area in large numbers.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. This deferral would slightly reduce adverse effects to gray and beluga whales during the fall migration period and fall feeding aggregations; however, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing, but it does protect key areas where known feeding concentrations have been documented. Potential displacement from prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. The deferral would buffer the blocks within the deferral by increasing the distance (effectively decreasing exposure to and high noise levels) between potential activities on adjacent, active OCS lease blocks. The effects of this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of any new leases and experience lower levels or fewer stress-inducing events, but effects are considered to be the same as under Alternative 2.

This deferral would exclude disturbance and collision impacts to nonendangered whales arising from exploration activities in the deferral for the remainder of the 5-Year Program period. These sources of potential adverse effects would occur farther away from a small portion of important migration and feeding habitats. While development is considered speculative, the elimination of potential lease blocks within the deferral area and increased distance between LA12 and whale habitats would conceivably decrease the percent chance of a large oil spill contacting, increase weathering of spilled oil prior to contact, and increase available spill-response time before contacting the feeding and migration habitats. Any OCS-related infrastructure (pipelines) still could occur on these blocks and potential for petroleum spills from pipelines and vessel fuel spills could still occur as noted in Section 4.4.2.6.3.1.4.

4.4.4.8.3.2. Cumulative Effects Under Alternative 4. Cumulative effects for this alternative result from the combination of the direct and indirect effects (above) and the cumulative effects under Alternative 1.

Ringed, Spotted, Ribbon, and Bearded Seals. Cumulative effects are similar to those described in Section 4.4.2.8.3.2. The extent to which this deferral reduces impacts to seals as compared to Alternative 2, the Proposed Action, would be negligible.

Pacific Walrus. Selecting this alternative would not substantially change the cumulative effects described under Alternative 2, the Proposed Action. The extent to which this deferral reduces impacts to walrus as compared to Alternative 2, the Proposed Action, would be negligible.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. This deferral would slightly reduce adverse effects to grey, minke, and beluga whales during the fall migration period and fall feeding aggregations; however, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing, but it does protect key areas where known feeding concentrations have been documented. Potential displacement from prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. The deferral would buffer the blocks within the deferral by increasing the distance (effectively decreasing exposure to and high noise levels) between potential activities on adjacent, active OCS lease blocks. The effects of this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of any new leases and experience lower levels or fewer stress-inducing events, but effects are considered to be the same as for Alternative 2. The cumulative effects of this alternative are similar to those described in Section 4.4.2.8.3.2. The extent to which this deferral reduces impacts to whales as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.4.9. Terrestrial Mammals. This alternative would defer 41 whole or partial lease blocks near Cross Island from the proposed Beaufort Sea sale area (Figure 2-1). The following analysis describes the anticipated effects to terrestrial mammals if the lease sale took place with this subarea deferral in the Beaufort Sea analysis area. The Cross Island deferral zone constitutes 0.6% of the Beaufort Sea Proposed Action area; however, the impacts to terrestrial mammals under this alternative would be similar to those under Alternative 2. In this section, we describe the anticipated effects on terrestrial mammals from the Proposed Action with mitigation measures in place. The effects under Alternative 4 versus Alternative 2 would be similar for terrestrial mammals. A complete description of the Proposed Action is located in Section 2.2 while the exploration and development scenario descriptions are located in Section 2.4.

This analysis identifies the anticipated level of effect for this alternative on terrestrial mammals. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.4.9.3.1) and cumulative effects (Section 4.4.4.9.3.2).

4.4.4.9.1. Potential Effects to Terrestrial Mammals. Potential effects are described in Section 4.4.1.9.1.

4.4.4.9.2. Mitigation Measures. Mitigation measures are the same as described in Section 4.4.2.9.2.

4.4.4.9.3. Anticipated Effects Under Alternative 4. The anticipated effects under Alternative 3 would be the same as those under Alternative 2, the Proposed Action.

4.4.4.9.3.1. Direct and Indirect Effects Under Alternative 4. Direct and indirect effects would be the same as those described under Alternative 2, the Proposed Action.

4.4.4.9.3.2. Cumulative Effects Under Alternative 4. Cumulative effects under Alternative 4 would be the same as those described under Alternative 2, the Proposed Action.

4.4.4.10 Vegetation and Wetlands. The effects to vegetation and wetlands under Alternative 4, Cross Island Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.4.11. Economy. Effects to economy under Alternative 4, Cross Island Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.4.12. Subsistence-Harvest Patterns and Resources.

4.4.4.12.1. Direct and Indirect Effects Under Alternative 4. This deferral would prohibit leasing, exploration, development, and production activities on approximately 38 whole or partial blocks off Cross Island, moving the zone for potential noise, disturbance, and oil-spill effects farther away from Nuiqsut subsistence-whaling areas.

Conclusion. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. Effects on subsistence-harvest patterns are expected to be reduced, because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. The chance of fall bowhead whale encounters with industrial noise would likely be reduced under Alternative 2, the Proposed Action. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. There would be no reduction in effects from potentially permitted seismic surveys onshore or in the sale area.

4.4.4.12.2. Cumulative Effects Under Alternative 4.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts would be expected. Deferring this area reduces the overall footprint of the lease sale in critical Nuiqsut subsistence bowhead whale-harvest areas; therefore, this deferral reduces to a minor degree the cumulative effects on harvest areas important to the Nuiqsut subsistence bowhead whale hunt described under Alternative 2, the Proposed Action.

4.4.4.13. Sociocultural Systems.

4.4.4.13.1. Direct and Indirect Effects Under Alternative 4. This deferral would prohibit leasing, exploration, development, and production activities in approximately 38 whole or partial blocks off Cross Island, moving the zone for potential noise, disturbance, and oil-spill effects farther away from Nuiqsut subsistence-whaling areas.

Conclusion. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. Effects on sociocultural systems are expected to be reduced by this deferral alternative to the extent they reduce effects on subsistence-harvest patterns, particularly Nuiqsut's subsistence bowhead whale hunt. Because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting, effects on sociocultural systems would be reduced accordingly. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. Effects on sociocultural systems likely would be reduced from those discussed under Alternative 2, The Proposed Action.

4.4.4.13.3. Cumulative Effects of Selecting Alternative 4.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts would be expected. Deferring this area reduces the overall footprint of the lease sale in critical Nuiqsut subsistence bowhead whale-harvest areas. By reducing cumulative effects on subsistence-harvest areas and subsistence practices, an expected consequent reduction of effects on sociocultural systems would also be

expected from Alternative 2, the Proposed Action. The extent to which this deferral reduces impacts to subsistence as compared to Alternative 2, the Proposed Action, would be minor.

4.4.4.14. Archaeological Resources.

4.4.4.14.1. Direct and Indirect Effects Under Alternative 4. This deferral would prohibit leasing, exploration, development, and production activities on approximately 38 whole or partial blocks off Cross Island.

Conclusion. The potential effects under Alternative 4 to archaeological resources would be essentially the same as discussed under Alternative 2, the Proposed Action, except the areas deferred would be removed from any bottom-disturbing activities. More potential effects are likely to occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Prehistoric and historic resources both onshore and offshore would be identified by archaeological surveys and avoided or mitigated.

4.4.4.14.2. Cumulative Effects Under Alternative 4.

Conclusion. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects to archaeological resources as compared to those under Alternative 2, the Proposed Action.

4.4.4.15. Environmental Justice.

4.4.4.15.1. Direct and Indirect Effects Under Alternative 4. This deferral would prohibit leasing, exploration, development, and production activities in approximately 38 whole or partial blocks off Cross Island, moving the zone for potential noise, disturbance, discharges, airborne emissions, and oil-spill effects farther away from Nuiqsut subsistence-whaling areas. Climate change, and economic, employment and demographic effects would be similar between this alternative and Alternative 2. By reducing potential subsistence impacts, Alternative 4 would reduce anticipated public health impacts relative to Alternative 2; this difference would be most evident in Nuiqsut, but would also be important in villages that receive shared subsistence resources from Nuiqsut. As described in Section 4.4.1.15 and subsections (Beaufort Sea Alternative 1, EJ), subsistence forms the foundation of health in rural Alaska Native villages. Adverse effects on subsistence can impact general health and well-being, diet and nutrition, injury rates, and rates of nutrition-related chronic diseases such as diabetes, hypertension, and cardiovascular disease.

Conclusion. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. Effects to EJ are expected to be reduced under this deferral alternative to the extent they reduce effects on subsistence-harvest patterns, sociocultural systems, and associated effects on public health. Because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, other marine mammal hunting, sociocultural systems, and public health, effects to EJ would be reduced accordingly. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from further offshore areas still would cross deferred areas. Effects to EJ likely would be reduced from those described for Alternative 2, the Proposed Action.

4.4.4.15.2. Cumulative Effects Under Alternative 4.

Conclusion. Nuiqsut has experienced cumulative impacts from past and present oil and gas exploration. Effects to subsistence harvest and use, and any associated stress to community social organization, are most likely to occur onshore in the community of Nuiqsut because of its proximity to oil-patch infrastructure at Alpine and Prudhoe Bay. Development is being considered for the Northeast NPR-A for Alpine Field Satellites development, and further exploration and delineation activity is ongoing in the leased areas south of Teshekpuk Lake. If oil and gas activities were to continue in areas already leased, Nuiqsut residents would be increasingly isolated from their subsistence resources and would be encircled by development. While community members of Barrow and Atqasuk all pursue subsistence activities in this area, they take a larger proportion of their subsistence harvest from other areas not directly affected and, thus, are less likely to experience subsistence-related disruption to their social organization.

In the past, non-Native workers have stayed in enclaves that kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. These workers already have made demands on the village for more electrical power and health care. This potential also remains for the community of Barrow and Atqasuk (USDOJ, BLM and MMS, 2003). Any OCS activities near Cross Island could add to these cumulative burdens, through impacts to Nuiqsut's subsistence whaling activities and through the possible increased influx of nonresident workers to and through the village, and therefore increase the risk of adverse effects on general health and well-being, diet and nutrition, injury rates, and rates of nutrition-related chronic diseases such as diabetes, hypertension, and cardiovascular disease. Because MMS is not considering the deferral of a larger region around and to the East of Cross Island recommended by Nuiqsut whalers (see Section 2.1.1.7), impacts to the Cross Island whale subsistence hunt still could occur.

By offering a reduced area for leasing, a reduction in adverse cumulative impacts as compared to those under Alternative 2, the Proposed Action, would be expected. Overall, deferring this area reduces the overall footprint of the lease sale in critical Nuiqsut subsistence bowhead whale-harvest areas and, therefore, reduces the cumulative effects on subsistence resources and harvests, associated effects to social systems and public health and, thus, consequent effects to EJ compared to the effects under Alternative 2, the Proposed Action.

4.4.5. Alternative 5, Beaufort Sea Eastern Deferral.

This alternative was developed by MMS in response to requests by the Native Village of Kaktovik and the AEWC. This alternative was developed to provide protection of the Nuiqsut subsistence bowhead whaling areas. This alternative would offer for lease all of the area described under Beaufort Sea Alternative 2, except for an area located east of Kaktovik. The proposed deferral area adjoins an area that the State of Alaska has deferred in recent State sales. This alternative would offer for lease 6,063 whole or partial blocks comprising approximately 32,910,672 acres (about 13.4 million hectares), minus any blocks currently leased at the time of the sale. The area deferred under this alternative consists of 80 whole or partial blocks, approximately 283,795 thousand acres (about 76 thousand hectares), which is about 0.8% of the Proposed Action area. This alternative would result in a reduction of 4% of the commercial resource potential from the Proposed Action.

4.4.5.1. Water Quality. Alternative 5 would not significantly reduce the estimated oil resource or the activities associated with exploration and development and production. Therefore, this alternative does not substantially lessen the effects on Beaufort Sea water quality for any of the activities discussed in Section 4.4.2.1. There would be some reduction of the local impacts within any deferred area from construction and permitted discharges, but the risk of effects from oil spills to the deferred area would be unaffected.

Conclusion. The effects of Alternative 5 are expected to be minor on local water quality and negligible on regional water quality, the same as under Alternative 2, the Proposed Action.

4.4.5.2. Air Quality. Effects to air quality under Alternative 5, Eastern Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.5.3. Lower Trophic-Level Organisms. As explained in Section 4.4.2.3.3, planktonic habitats that are productive and usually grazed by bowhead whales are located along the coast to the east of Kaktovik (Section 3.3.1). The area corresponds to ERA44 (Kaktovik; Appendix A.1, Maps A.1-2a and 2c). The OSRA model estimates a <0.5-29% chance of a large spill from any launch area within the proposed Beaufort lease sale area contacting ERA44 within 30 days during summer (Table A.2-5). Without LA18 in the Kaktovik deferral, the chance of a large spill contacting is similar: the OSRA model estimates a <0.5-29% chance of a large spill from other launch areas contacting ERA44. The LA18 has a chance of contacting LSs 107-115 (Kaktovik to Herschel Island) within 30 days during summer. Part of the reason is that the chance of contact to nearshore areas near Kaktovik is due to both nearshore and offshore launch areas, as explained in Section 4.4.2.3.3. Therefore, the relatively small Eastern Deferral would not alter the level of effects on lower trophic-level organisms from disturbance, discharges, or spills.

Three aspects of the proposed lease sales that might affect the organisms are physical disturbance, discharges, and spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting up to a thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms likely would recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later; some assessments might need more accurate information on recolonization and coastal erosion rates.

Standard restrictions of exploratory discharges into shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that the discharge and reinjection practice would continue; however, any discharge proposals would be reviewed by MMS and EPA.

The OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring over a 20-year production (Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup would present substantial challenges (Section 4.3.3.1.7). The OSRA model estimates that there is a <0.5-43% chance that a large spill would contact the Alaskan Beaufort coastline within 10 days during summer, but that the maximum chance is only 18% for a 3-day trajectory. The difference indicates a reduction in impact to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.5). The estimate increases up to 43% within 10 days, indicating a reduction in impact to lower trophic-level organisms, given the requirement for rapid-response capabilities (Section 4.3.3.1.5.6). If such spills contact the coastline, the oil probably would affect an estimated 29 km (18 mi) of coastline, persisting in a few noneroding areas for more than a decade. Organisms that inhabit these areas probably would experience larger and longer term effects than pelagic or benthic organisms.

The Eastern Deferral is adjacent to an area of high plankton production near Barter Island (Section 3.3.1). Moderation of effects on this area could be achieved by an alternative to the deferral—by the discontinuation of leasing incentives in the Eastern Deferral. The rationale for leasing incentives is summarized in Section 4.1.2; it is partly to encourage additional industry activities in remote areas, leading to commercial production. So, the exclusion of leasing incentives from the Eastern Deferral area would allow the previous rate of development to continue.

Conclusion: Effects Under Alternative 5 on Lower Trophic-level Organisms. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a reduction in impact to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of ongoing climate change, would be major. The extent to which this deferral reduces impacts to lower trophics as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.5.4. Fish Resources.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to fish resources, because fish resources and fish habitat in the immediate deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate fish

resources from certain activities, the anticipated environmental consequences to fish resources would be similar to those determined under Alternative 2.

4.4.5.4.1. Potential Effects to Fish Resources. Potential effects to fish resources in the Beaufort Sea were described in Section 4.4.1.4.1 and are not repeated here.

4.4.5.4.2. Mitigation Measures. The potential effects can be moderated by application of the mitigation measures listed in Section 4.4.2.4.2.

4.4.5.4.3. Anticipated Effects Under Alternative 5. This deferral would reduce the size of the lease-sale area, but it was not specifically designed to minimize adverse effects to fish resources. This deferral could serve to protect fish resources and fish habitat in the immediate deferral area from potentially injurious activities associated with oil and gas exploration and development. Deferral areas commonly are associated with nearby communities and traditional subsistence-use areas. This nearshore deferral could serve to delay the time it would take for a large spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall impact to fish resources. Because of the small degree to which this alternative would separate fish resources from certain activities, the anticipated environmental consequences to fish resources would be similar to those determined under Alternative 2. The extent to which this deferral reduces impacts to fish resources as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.5.5. Essential Fish Habitat.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size would reduce adverse effects to EFH, because EFH in the immediate area of the deferral area would be somewhat protected from potentially injurious activities associated with OCS oil and gas exploration and development. Because of the small degree to which this alternative would separate EFH from certain activities, the anticipated environmental consequences to EFH would be similar to those determined under Alternative 2.

4.4.5.5.1. Potential Effects to Essential Fish Habitat. The potential effects to EFH in the Beaufort Sea were described in Section 4.4.1.5.1 and are not repeated here.

4.4.5.5.2. Mitigation Measures. The potential effects can be moderated by application of the mitigation measures identified in Section 4.4.2.5.2.

4.4.5.5.3. Anticipated Effects Under Alternative 5. This deferral would reduce the size of the lease-sale area. This deferral was not specifically designed to minimize adverse effects to EFH. This deferral could serve to protect EFH in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. Deferral areas commonly are associated with nearby communities and traditional subsistence-use areas. This nearshore deferral could serve to delay the time it would take for a large oil spill to contact adjacent land segments, estuaries, and shorelines known to be important to fish, thereby reducing the overall effects on EFH. Because of the small degree to which this alternative would separate EFH from certain activities, the anticipated environmental consequences to EFH would be similar to those determined under Alternative 2. The extent to which this deferral reduces impacts to EFH as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.5.6. Threatened and Endangered Species.

4.4.5.6.1. Threatened and Endangered Whales.

Summary. The direct, indirect, and cumulative effects of this alternative may improve slightly over those under Alternative 2, the Proposed Action (Section 4.4.2.6.1.), but reductions in impact are uncertain and effects are considered to be the same (negligible to minor) as under Alternative 2. The ESA-listed whales that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning areas are the bowhead whale, fin whale, and humpback whale; however, current evidence indicates fin whales do not occur in the Beaufort Sea Planning Area.

After reviewing the current status of endangered bowhead, fin, and humpback whales, the environmental baseline for the action area, the Proposed Action, and the cumulative effects, it is NMFS's biological opinion that individual bowhead, fin, and humpback whales within the action area may be adversely affected, but that the Proposed Action is not likely to jeopardize the continued existence of Western Arctic Bowhead whales, North Pacific fin whales, or humpback whales. No critical habitat has been designated for these species; therefore, none will be affected. The NMFS concludes at this time that there is reasonable likelihood that oil and gas development and production in the Alaska Beaufort and Chukchi seas, as described, would not violate Section 7(a)(2) of the ESA (NMFS, 2008c).

The following analysis describes potential adverse effects to endangered whales from OCS activities associated with oil and gas exploration and development activities as described in Section 2.4.1, Scenario for the "Typical" Beaufort Sea Lease Sale (Sales 209 and 217). Anticipated effects discussed herein consider mitigation measures applied to potential effects to determine the effects of Alternative 5, the Eastern Deferral, on bowhead, fin, and humpback whales. In this section, we address the most important differences between the Proposed Action (Alternative 2) and this alternative.

4.4.5.6.1.1. Potential Effects to Threatened and Endangered Whales. Potential effects to endangered whales were described in Section 4.4.1.6.1.1 and apply to activities identified under Alternative 5, the Eastern Deferral, that could occur if the entire Beaufort Sea Planning Area, except the deferral area, would be open to proposed Lease Sales 209 and 217. Potential effects described in Section 4.4.1.6.1.1 remain identical for all alternatives, including the Eastern Deferral and will not be repeated here.

4.4.5.6.1.2. Mitigation Measures. The mitigation measures listed in Sections 4.4.1.6.1.2 and 4.4.2.6.1.2 are applied, as appropriate, to OCS activities to protect ESA-listed whales and other marine mammals during Federal seismic and exploratory drilling in the Beaufort and Chukchi seas. It is anticipated these mitigation measures would be implemented in future activities associated with all alternatives for Lease Sale 209 and 217, including the Eastern Deferral.

4.4.5.6.1.3. Anticipated Effects Under Alternative 5. This section describes the important differences in the anticipated effects between Alternative 2, the Proposed Action and Alternative 5, the Eastern Deferral. Anticipated effects consider mitigation measures and specific biological and activity characteristics discussed in Sections 4.4.1.6.1.2 and 4.4.2.6.1.2.

4.4.5.6.1.3.1. Direct and Indirect Effects Under Alternative 5.

Summary. This deferral would reduce impacts to bowhead whales during the fall migration period and fall feeding aggregations; however, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing. It does, however, protect key areas where known feeding concentrations have been documented. Potential displacement from prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. The deferral would buffer the blocks within the deferral by increasing the distance (effectively decreasing exposure to and high noise levels) between potential activities on adjacent, active OCS lease blocks. The effects analysis and conclusions are slightly improved. It is uncertain whether the effects under this alternative would result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of the Proposed Action and experience lower level or fewer stress-inducing events, but effects are considered to be similar as under Alternative 2.

The primary reduction in impacts of this deferral would be to exclude disturbance and collision impacts to endangered whales arising from exploration activities in deferred blocks. These sources of potential adverse effects would occur farther away from an important portion of bowhead whale migration and feeding habitat. While development is considered speculative, the elimination of LA18 and increased distance between potential launch areas on lease blocks and whale habitats conceivably would decrease the percent chance of a large spill contacting, increase weathering of spilled oil prior to contact, and increase available spill-response time before contacting the migration and feeding habitat. Any OCS related infrastructure (pipelines) still could occur on these blocks, and potential for petroleum spills from these and vessel fuel spills still could occur, as noted in Section 4.4.2.6.1.3.8.

4.4.5.6.1.3.2. Cumulative Effects Under Alternative 5.

Summary. The cumulative effects under this alternative are considered to be the same as under Alternative 2, the Proposed Action.

As explained in Section 4.4.5.6.1.3.1, Direct and Indirect Effects under Alternative 5, the Eastern Deferral, would reduce impacts to endangered whales during the bowhead migration periods and period of concentrated summer-fall feeding. Its moderate size and location limits those reductions in impacts, but the effects analysis and conclusions are moderately improved compared to those under Alternative 2. Alternative 5 would not allow oil- and gas-related activities during periods when endangered whales are present or access to petroleum resources via extended reach technology from adjacent active lease blocks. The reduced impact level reduces the total cumulative effect. Impacts to endangered whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a negative, moderate level of effect on whales; however, the exposure of the Eastern Deferral area to levels of vessel traffic and activities would be proportionately less than nearshore and offshore areas to the west. This is because there are fewer villages in Canada to be served by barge and other traffic. The greatest source of large, noncrude oil spills would continue to arise from bulk-fuel deliveries to Canadian coastal villages and oil and gas operations. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on endangered whales in the Beaufort and Chukchi seas. Continued climate change is likely to continue and, although speculative and unpredictable at this time, effects may be positive and/or adverse to endangered whales or their habitat in the Beaufort Sea.

4.4.5.6.2. Threatened and Endangered Birds.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in the proposed lease-sale area would not result in a change to the level of effect to threatened eiders, because the deferral area is not used by listed eiders. The cumulative effects are anticipated to be the same as those under Alternative 2.

This alternative removes approximately 60 full or partial blocks offshore of Demarcation Bay (Figure 2-1) from the lease-sale area.

4.4.5.6.2.1. Potential Effects to Threatened and Endangered Birds. The potential effects would be the same as those described in Section 4.4.1.6.2.1.

4.4.5.6.2.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.5.6.2.3. Anticipated Effects Under Alternative 5. This analysis identifies the anticipated level of effect under this alternative to threatened and endangered birds. The anticipated effects are separated into the direct and indirect effects (Section 4.4.5.6.2.3.1) and the cumulative effects (Section 4.4.5.6.2.3.2).

4.4.5.6.2.3.1. Direct and Indirect Effects Under Alternative 5. This deferral reduces the size of the lease-sale area. This deferral excludes an area that is not used by listed eiders. The effects under this alternative are the same as under Alternative 2.

4.4.5.6.2.3.2. Cumulative Effects Under Alternative 5. This deferral reduces the size of the lease-sale area. This deferral excludes an area that is not used by listed eiders. The cumulative effects under this alternative are the same as those under Alternative 2.

4.4.5.3.6.3. Polar Bear.

Conclusions. Alternative 5 could decrease potential adverse effects to polar bears by protecting an area adjacent to part of the shoreline of ANWR. This is a known polar bear denning area (USGS, unpublished data, 2007). The primary reductions in impacts to polar bears under this deferral would be to buffer the shoreline of the coastal denning areas. This deferral also would protect a small amount of seal habitat that may reduce impacts to foraging polar bears. This deferral would slightly improve the effects determination for polar bears.

4.4.5.3.6.3.1. Direct and Indirect Effects Under Alternative 5. This deferral area would remove approximately 60 full and partial lease blocks. The direct effect under this alternative is to protect a small amount of polar bear habitat near ANWR and to buffer a known denning area (USGS, unpublished data, 2007). This is expected to have minor reductions in impacts to polar bears. Indirectly, this alternative also would protect a small amount of seal habitat, the primary prey of the polar bear. If deferred, this area would be protected from habitat alteration. In addition, it would provide a small buffer between potential development activities, the associated chance of oil spills, and the shoreline. This includes shoreline occasionally used for den sites. This added buffer potentially could afford additional time for cleanup workers to respond to a spill before it reaches the shoreline. Alternative 5 would remove LA18. The OSRA model estimates LA18 has the highest chance of spill from any launch area contacting ANWR

during winter. However, the chance of one or more large spills occurring and contacting the shoreline is very small (<1%), regardless of the deferral.

4.4.5.3.6.3.2. Cumulative Effects Under Alternative 5. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects. Alternative 5 would have a minor effect on the overall level of impacts to polar bears.

4.4.5.7. Marine and Coastal Birds.

Summary. The removal of approximately 60 full and partial lease blocks offshore of Demarcation Bay would decrease the size of the lease-sale area by excluding an area used by marine and coastal birds during the open-water period; however, its location and size reduces adverse effects only slightly compared to Alternative 2. The anticipated level of effects under this alternative are considered to be the same as under Alternative 2.

4.4.5.7.1. Potential Effects to Marine and Coastal Birds. The potential effects would be the same as those described in Section 4.4.1.6.2.1.

4.4.5.7.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.5.7.3. Anticipated Effects Under Alternative 5. This analysis identifies the anticipated level of effect under Alternative 5 to marine and coastal birds. The anticipated effects are separated into the direct and indirect effects (Section 4.4.5.7.3.1) and the cumulative effects (Section 4.4.5.7.3.2).

4.4.5.7.3.1. Direct and Indirect Effects Under Alternative 5. The removal of approximately 60 full and partial lease blocks offshore of Demarcation Bay would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and size only slightly reduces adverse effects compared to Alternative 2. The anticipated level of effects under this alternative is considered to be the same as under Alternative 2.

The primary difference of this deferral for marine and coastal birds compared to Alternative 2 would be to exclude disturbance and collision impacts to birds arising from exploration drilling in these blocks for the remainder of the 5-Year Program period. These sources of potential adverse effects would occur farther away from important coastal bird habitats, particularly staging, migrating, and broodrearing areas. This deferral also would move certain activities further from the ANWR coastline, important to shorebirds. While development is considered speculative, the increased distance between offshore development and coastal bird habitats conceivably would decrease the chance of a large spill contacting important bird habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time. Habitat alterations and surface developments still could occur in adjacent areas.

4.4.5.7.3.2. Cumulative Effects Under Selecting Alternative 5. As explained in Section 4.4.5.7.3.1, the Eastern Deferral would reduce adverse effects to marine and coastal birds during the open-water period; however, its location and size only slightly reduces adverse effects compared to those under Alternative 2. The reduced impact level slightly reduces the total cumulative effect. Impacts to marine and coastal birds from (1) continued community and oil and gas infrastructure developments, (2) collisions with community and oil and gas infrastructure facilities, and (3) disturbances to eiders in nearshore areas from unrestricted vessel and low-flying aircraft traffic (all unrelated to OCS leasing activities) would continue to have a negative, moderate level of effect on marine and coastal birds. The

greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could dramatically increase the potential for marine accidents and large fuel spills, which could result in a major level of adverse effect on marine and coastal bird populations in the Beaufort Sea. Continued climate change is likely to result in a major level of effect to marine and coastal birds. The extent to which this deferral reduces impacts to marine and coastal birds as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.5.8. Other Marine Mammals. This alternative would offer about 6,063 whole or partial lease blocks in the lease sale area (Figure 2-1). The following analyses describe the anticipated effects under Alternative 5, the Eastern Deferral, on marine mammals in the Alaskan Beaufort Sea. The Eastern Deferral constitutes about 10% of the Beaufort Sea lease sale area.

Ringed, Spotted, Ribbon, and Bearded Seals. The effect on ice seals under this alternative would be similar to those under Alternative 2.

Pacific Walrus. Alternative 5 would defer an area adjacent to part of the shoreline of ANWR. This area is not heavily used by walrus, although it is difficult to predict changing trends in walrus use of the Beaufort Sea. This deferral would not change the effects determination for walrus from those under Alternative 2.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. The direct, indirect and cumulative effects of this alternative would be slightly reduced compared to those determined under Alternative 2, the Proposed Action, but the reduction is small and effects are considered to be the same (negligible to minor) as under Alternative 2. Baleen whales other than ESA-listed species that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning areas are minke and gray whales; however, current evidence indicates minke whales do not occur in the Beaufort Sea Planning Area. Beluga whales are the only toothed whales known to regularly occur in the Proposed Action area.

4.4.5.8.1. Potential Effects to Marine Mammals. The potential effects to non-ESA-listed marine mammals in the Beaufort Sea were described in Section 4.4.1.8.1. Potential effects specific to whales that also may apply to gray whales are described in Section 4.4.1.6.1.1.

4.4.5.8.2. Mitigation Measures. The potential effects can be moderated by the mitigation measures identified in Section 4.4.2.8.2.

4.4.5.8.3. Anticipated Effects Under Alternative 5. In this section, we determined the anticipated level of effect on marine mammals if MMS opens the lease-sale area with the Eastern Deferral in the Beaufort Sea. These anticipated effects consider mitigation measures identified in Section 4.4.2.8.2. We defined the terms used to describe the anticipated level of effect in Section 4.4.1.8.3. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.5.8.3.1) and cumulative effects (Section 4.4.5.8.3.2).

4.4.5.8.3.1. Direct and Indirect Effects Under Alternative 5.

Ringed, Spotted, Ribbon, and Bearded Seals. Deferring the area around Kaktovik from leasing could slightly lessen the indirect chance of disturbances occurring. However, this deferral can be

expected to result in added scrutiny of the leased areas through reallocation of resources, leading to a level of direct and indirect effects similar to those described in 4.4.2.8.3.1 for the Alaskan Beaufort Sea.

Pacific Walrus. There would be no substantial direct or indirect effects under this alternative on walrus.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. The direct and indirect effects under this alternative may be slightly reduced, but not substantially compared to those under Alternative 2, the Proposed Action, in Section 4.4.2.8.3.1, and the effects are similar to those under Alternative 2 (a negligible to minor level of effect).

4.4.5.8.3.2. Cumulative Effects Under Alternative 5. Cumulative effects under this alternative result from the combination of the direct and indirect effects (above) and the cumulative effects under Alternative 1.

Ringed, Spotted, Ribbon, and Bearded Seals. Cumulative effects are similar to those described throughout Section 4.4.2.8.3.2.

Pacific Walrus. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects. This alternative would not change the negligible effects determination described in 4.4.2.8. Anticipated effects are similar to those described in Section 4.4.2.8.3.2.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. The Eastern Deferral would slightly reduce adverse effects to gray and beluga whales during migration periods and periods of concentrated summer-fall feeding; however, its small size limits the reduction and the effects analysis and conclusions are only slightly reduced compared to those under Alternative 2. The Eastern Deferral would not allow oil- and gas-related activities during periods when whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level slightly reduces the total cumulative effect in relation to Alternative 2, the Proposed Action.

Impacts to whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a negligible to minor level of effect on whales. The greatest source of large, noncrude oil spills would continue to come from bulk fuel deliveries to coastal villages. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in minor adverse effects to low numbers of beluga and gray whales in the Beaufort and Chukchi seas. Trends in climate change are likely to continue and although speculative and unpredictable at this time, effects may be positive and/or adverse to whales or their habitat in the Beaufort Sea.

4.4.5.9. Terrestrial Mammals. This alternative would defer approximately 60 whole or partial lease blocks around Kaktovik from the proposed Beaufort Sea lease sales (Figure 2-1). The following analysis describes the anticipated effects to terrestrial mammals if the lease sale took place with the Barrow subarea deferral in the Beaufort Sea analysis area. Although the Kaktovik deferral zone constitutes 0.8% of the Beaufort Sea analysis area, the impacts to terrestrial mammals under this alternative would be similar to those under Alternative 2. In this section, we describe the anticipated effects on terrestrial mammals from the Proposed Actions with mitigation measures in place. The effects under Alternative 5 versus Alternative 2 are similar for terrestrial mammals. A complete description of the Proposed Action is located in Section 2.2, while the exploration, and development scenario descriptions are located in Section 2.4 and Appendices B and E.

This analysis identifies the anticipated level of effect for this alternative on terrestrial mammals. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.5.9.3.1.) and cumulative effects (Section 4.4.5.9.3.2.).

4.4.5.9.1. Potential Effects to Terrestrial Mammals. Potential effects are described in Section 4.4.1.9.1.

4.4.5.9.2. Mitigation Measures. Mitigation measures are the same as described in Section 4.4.2.9.2.

4.4.5.9.3. Anticipated Effects Under Alternative 5. The anticipated effects under Alternative 5 are the same as those described in Section 4.4.2.9.3.

4.4.5.9.3.1. Direct and Indirect Effects Under Alternative 5. The effects are the same as those described in Section 4.4.2.9.3.1.

4.4.5.9.3.2. Cumulative Effects Under Alternative 5. The effects are the same as those described in Section 4.4.2.9.3.2.

4.4.5.10. Vegetation and Wetlands. The effects to vegetation and wetlands under Alternative 5, Eastern Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.5.1.1. Economy. The effects to economy under Alternative 5, Eastern Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.5.12. Subsistence-Harvest Patterns and Resources.

4.4.5.12.1. Effects Under Alternative 5 to Subsistence-Harvest Patterns. This alternative would offer for leasing all of the area described under Alternative 2, except for a subarea located east of Kaktovik. The area removed by the Eastern Deferral consists of approximately 60 whole or partial blocks. This deferral was developed to protect bowhead whale habitat and to buffer potential impacts to Kaktovik subsistence whaling areas, as requested by the Native Village of Kaktovik and the AEW. This area adjoins an area that the State of Alaska has deferred in recent State lease sales.

4.4.5.12.2. Direct and Indirect Effects Under Alternative 5. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. This deferral would prohibit leasing, exploration, development, and production activities in the deferred area, moving the zone for potential noise, disturbance, and oil-spill effects farther away from Kaktovik subsistence bowhead-whaling areas.

Conclusion. Effects on subsistence-harvest patterns are expected to be reduced, because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on bowhead whale habitat and whales traveling westward into Kaktovik subsistence whaling areas. The chance of fall bowhead whale encounters with industrial noise likely would be reduced from Alternative 2, the Proposed Action. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. There would be no reduction in effects from potentially permitted seismic surveys onshore or in the sale area.

4.4.5.12.3. Cumulative Effects Under Alternative 5.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts would be expected. Deferring this area reduces the overall footprint of the lease sale in critical bowhead whale habitat; therefore, Alternative 5 reduces the cumulative noise effects to migrating bowhead whales pursued by Kaktovik subsistence whalers as compared to the effects under Alternative 2, the Proposed Action.

4.4.5.13. Sociocultural Systems.

4.4.5.13.1. Direct and Indirect Effects Under Alternative 5. This deferral removes approximately 60 whole or partial blocks east of Kaktovik and would prohibit leasing, exploration, development, and production activities in the deferred area, moving the zone for potential noise, disturbance, and oil-spill effects farther away from Kaktovik subsistence bowhead whaling areas.

Conclusion. Effects to sociocultural systems are expected to be reduced by this deferral alternative to the extent it reduces effects to subsistence-harvest patterns, particularly Kaktovik's subsistence bowhead whale hunt. Because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts to bowhead whale habitat and whales traveling westward into Kaktovik subsistence whaling areas, effects on sociocultural systems would be reduced accordingly. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from further offshore areas still would cross deferred areas. Effects to sociocultural systems under Alternative 5 likely would be reduced from Alternative 2, the Proposed Action.

4.4.5.13.2. Cumulative Effects Under Alternative 5.

Conclusion. Deferring this area reduces the overall footprint of the lease sale in critical bowhead whale habitat; therefore, this deferral reduces the cumulative noise effects on migrating bowhead whales pursued by Kaktovik subsistence whalers and consequent effects to sociocultural systems under Alternative 2, the Proposed Action.

4.4.5.14. Archaeological Resources.

4.4.5.14.1. Direct and Indirect Effects Under Alternative 5. This deferral would prohibit leasing, exploration, development, and production activities on approximately 60 whole or partial blocks east of Kaktovik.

Conclusion. The potential effects under Alternative 5 to archaeological resources would be essentially the same as discussed under Alternative 2, the Proposed Action, except the areas deferred would be removed from any bottom-disturbing activities. More potential effects are likely to occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Prehistoric and historic resources both onshore and offshore would be identified by archaeological surveys and avoided or mitigated.

4.4.5.14.2. Cumulative Effects Under Alternative 5.

Conclusion. Deferring this area slightly reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects to archaeological resources under Alternative 2, the Proposed Action.

4.4.5.15. Environmental Justice.

4.4.5.15.1. Direct and Indirect Effects Under Alternative 5. This deferral removes approximately 60 whole or partial blocks east of Kaktovik and would prohibit leasing, exploration, development, and production activities in the deferred area, moving the zone for potential noise, disturbance, discharges, airborne emissions, and oil-spill effects farther away from Kaktovik subsistence bowhead whaling areas. Climate change, and economic, employment and demographic effects would be similar between this alternative and Alternative 2. By reducing potential subsistence impacts, Alternative 5 would reduce anticipated public health impacts relative to Alternative 2; this difference would be most evident in Kaktovik. As described in section 4.4.1.15 and subsections (Beaufort Sea Alternative 1, EJ), subsistence forms the foundation of health in rural Alaskan Native villages. Adverse effects to subsistence can impact general health and well-being, diet and nutrition, injury rates, and rates of nutrition-related chronic diseases such as diabetes, hypertension, and cardiovascular disease.

Conclusion. Effects to EJ are expected to be reduced by this deferral alternative to the extent it reduces effects to subsistence-harvest patterns, sociocultural systems, and associated effects to public health. Because no exploration or production activities would occur in the deferral area, a reduction in sources for chronic noise and disturbance impacts to bowhead whale habitat and to whales traveling westward into Kaktovik subsistence whaling areas would be expected. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas still would cross deferred areas. Effects to EJ likely would be reduced from Alternative 2, the Proposed Action.

4.4.5.15.2. Cumulative Effects Under Alternative 5.

Conclusion. Deferring this area reduces the overall footprint of the lease sale in critical bowhead whale habitat; therefore, this deferral reduces the cumulative noise effects to migrating bowhead whales pursued by Kaktovik subsistence whalers, effects on sociocultural systems, associated effects on public health, and consequent effects to EJ from Alternative 2, the Proposed Action.

4.4.6. Alternative 6, Beaufort Sea Deepwater Deferral.

Available information indicates that the deepwater area of the Beaufort Sea (the area below the continental shelf) is unlikely to contain economically viable fields. This alternative was developed by MMS to reduce unnecessary work on an area likely to have low industry interest and to help focus the NEPA process on the issues and environmental resources of areas likely to receive bids, should a lease sale be held. This alternative would offer for lease 1,766 whole or partial blocks comprising approximately 9,096,834 acres (about 8.8 million hectares), minus any blocks currently leased at the time of the sale. The area deferred under this alternative consists of 4,357 whole blocks, approximately 24,097,633 acres (about 9.7 million hectares), which is about 71% of the Proposed Action area. This deferral would result in a negligible reduction of the oil and gas potential from the Proposed Action.

4.4.6.1. Water Quality. Alternative 6 would not significantly reduce the activities associated with exploration and development and production as compared to Alternative 2, the Proposed Action. Therefore, this alternative does not substantially lessen the effects on Beaufort Sea water quality for any of the activities as compared to Alternative 2, the Proposed Action, discussed in Section 4.4.2.1. There would be some reduction of the local impacts within any deferred area from construction and permitted discharges, but the risk of effects from oil spills to the deferred area would remain the same as under Alternative 2, the Proposed Action.

Conclusion. The effects under Alternative 6 are expected to be minor on local water quality and negligible on regional water quality, the same as under Alternative 2, the Proposed Action.

4.4.6.2. Air Quality. Effects to air quality under Alternative 6, Deepwater Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.6.3. Lower Trophic-Level Organisms.

As explained in Section 4.4.2.3.3, the effects of discharges and spills would be most serious near to the coast, so the Deepwater Deferral would not reduce the most serious effects. However, one effect—disturbance of benthos by pipeline construction—would be very different. Any pipeline systems to deepwater areas might be very long and disturb much benthos; however, the deepwater benthos is affected by ice keels, so the benthic communities are disturbed naturally.

Three aspects of the proposed lease sales that might affect the organisms are physical disturbance, discharges, and spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting up to a thousand acres of typical benthic organisms on the inner Beaufort shelf. The benthic organisms likely would recolonize most of the disturbed areas within a decade, similar to the slow recolonization of ice gouges. If, however, some structures are proposed for areas with special biological communities, such as kelp or pockmark communities, the site-specific disturbance effects would be greater. Site-specific effects would be assessed later; some assessments might need more accurate information on recolonization and coastal erosion rates.

Standard restrictions of exploratory discharges into shallow and under-ice water would avoid local contamination of benthic organisms during most operations. Produced water from all developments to date have been reinjected rather than discharged. This assessment assumes that the discharge and reinjection practice would continue; and any discharge proposals would be reviewed by MMS and EPA.

The OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring over a 20-year production life (Section 4.3.2.1.4). If the assumed spills occur in broken ice, cleanup would present

substantial challenges (Section 4.3.3.1.7). For all launch areas, the OSRA model estimates that there is a <0.5-43% chance that a summer spill would contact the Alaskan coastline within 10 days during summer, but that the maximum chance is only 18% for a 3-day trajectory. For the launch areas within the Deepwater Deferral area, there is a <0.5-15% chance of contacting the U.S. Beaufort Coast within 10 days (Table A.2-87). The difference indicates a reduction in impacts to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If such spills contact the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. Organisms that inhabit these areas would probably experience larger and longer term effects than pelagic or benthic organisms.

Conclusions. Three aspects of the proposed lease sales that might affect benthic, intertidal, and other lower trophic-level organisms are physical disturbance, discharges, and oil spills. Disturbance would be caused by additional bottom-founded platforms, drilling islands, and especially buried pipelines, affecting an estimated thousand acres (404 hectares) of typical benthic organisms on the inner Beaufort shelf. The benthic organisms would likely recolonize most of the disturbed areas within a decade, similar to the slow recolonization rate of ice gouges. This assessment estimates that there is a medium chance (<43%) that a summer spill would contact the Alaskan coastline within 10 days, but that the chance is low (<18%) for a 3-day trajectory. The difference indicates a reduction in impacts to lower trophic-level organisms from requirements for rapid-response capabilities (Section 4.3.3.1.5.6). If a large spill contacted the coastline, the oil probably would affect an estimated 29 km (18 mi) of intertidal habitat, persisting in a few noneroding areas for more than a decade. We conclude above that the level of direct and indirect effects of foreseeable operations on lower trophic-level organisms would be minor. The cumulative level of effects includes the effect of ongoing climate change. As explained in Section 3.3.1, the change would have a widespread, annual, population-level effect on epontic (under ice) and other lower-trophic organisms that depend on a summer/autumn ice cover. So, the cumulative level of effects, including the effect of ongoing climate change, would be major. The extent to which this deferral reduces impacts to lower trophics as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.4. Fish Resources.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size could serve to protect fish resources and fish habitat in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action.

4.4.6.4.1. Potential Effects to Fish Resources. The potential effects to fish resources in the Beaufort Sea were described for Alternative 2, the Proposed Action, in Section 4.4.1.4.1.

4.4.6.4.2. Mitigation Measures. The potential effects can be moderated by application of the mitigation measures identified for Alternative 2, the Proposed Action, in Section 4.4.2.4.2.

4.4.6.4.3. Anticipated Effects Under Alternative 6. This deferral reduces the size of the lease sale area, but it was not specifically designed to minimize adverse effects to fish resources. This deferral could serve to protect fish resources and fish habitat in the immediate deferral area from potentially injurious activities associated with oil and gas exploration and development. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action. The extent to which this deferral reduces impacts to fish resources as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.5. Essential Fish Habitat.

Summary. This deferral would reduce the size of the lease-sale area. This reduction in size could serve to protect EFH in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action. The extent to which this deferral reduces impacts to EFH as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.5.1. Potential Effects to Essential Fish Habitat. The potential effects to EFH in the Beaufort Sea lease sale area were described for Alternative 2, the Proposed Action, in Section 4.4.1.5.1.

4.4.6.5.2. Mitigation Measures. The potential effects can be moderated by application of the mitigation measures identified for Alternative 2, the Proposed Action, in Section 4.4.2.5.2.

4.4.6.5.3. Anticipated Effects Under Alternative 6. The deferral would reduce the size of the lease-sale area. It was not specifically designed to minimize adverse effects to EFH. The deferral could serve to protect EFH in the immediate deferral area from potentially injurious activities associated with OCS oil and gas exploration and development. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action.

4.4.6.6. Threatened and Endangered Species.

4.4.6.6.1. Threatened and Endangered Whales.

Summary. The direct, indirect and cumulative effects of this alternative may slightly improve over those under Alternative 2, the Proposed Action (Section 4.4.2.6.1.), but reductions in impacts are not substantial and effects are considered to be the same (negligible to minor) as under Alternative 2. The ESA-listed whales that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas, or that potentially could be adversely affected by activities within these planning units are the bowhead whale, fin whale, and humpback whale; however current evidence indicates fin whales do not occur in the Beaufort Sea Planning Area.

After reviewing the current status of endangered bowhead, fin, and humpback whales, the environmental baseline for the action area, the Proposed Action, and the cumulative effects, it is NMFS's biological opinion that individual bowhead, fin, and humpback whales within the action area may be adversely affected, but that the Proposed Action is not likely to jeopardize the continued existence of Western Arctic Bowhead whales, North Pacific fin whales, or humpback whales. No critical habitat has been designated for these species: therefore, none will be affected. The NMFS concludes at this time that there is reasonable likelihood that oil and gas development and production in the Alaska Beaufort and Chukchi seas, as described, would not violate Section 7(a)(2) of the ESA (NMFS, 2008c).

The following analysis describes potential adverse effects to endangered whales from OCS activities associated with oil and gas exploration and development activities as described in Section 2.4.4, Scenario for the "Typical" Beaufort Sea Lease Sale (Sales 209 and/or 217). Anticipated effects discussed herein consider mitigation measures applied to determine the effects under Alternative 6, the Deepwater Deferral, on bowhead, fin, and humpback whales. In this section, we address the important differences between the Proposed Action (Alternative 2) and this alternative.

4.4.6.6.1.1. Potential Effects to Threatened and Endangered Whales. Potential effects to endangered whales were described in Section 4.4.1.6.1.1 and apply to activities identified under Alternative 6, the Deepwater Deferral, that could occur if the entire Beaufort Sea Planning Area, except for the Deepwater Deferral area, would be open to proposed lease sales 209 and 217. Potential effects described in 4.4.1. 6.1.1 remain identical for all alternatives, including this alternative, and are not repeated here.

4.4.6.6.1.2. Mitigation Measures. The measures listed in Sections 4.4.1.6.1.2 and 4.4.2.6.1.2. are applied, as appropriate, to OCS activities to protect ESA-listed whales and other marine mammals during Federal seismic and exploratory drilling in the Beaufort Sea and Chukchi Sea. It is anticipated these mitigation measures would be implemented in future activities associated with all alternatives for Lease Sale 209 and/or 217, including the Deepwater Deferral.

4.4.6.6.1.3. Anticipated Effects Under Alternative 6. This section describes the most important differences in the anticipated effects between Alternative 2, the Proposed Action and Alternative 6, Deepwater Deferral. Anticipated effects consider mitigation measures and specific biological and activity characteristics discussed in Sections 4.4.1.6.1.2 and 4.4.2.6.1.2.

4.4.6.6.1.3.1. Direct and Indirect Effects Under Alternative 6.

Summary. This deferral removes 4,357 whole or partial blocks from the lease sale and would reduce impacts to bowhead whales during the fall migration period and fall feeding aggregations; however, its small size may not add substantially to the contiguous State and OCS areas to the west that are not subject to leasing. It does, however, protect key areas where known feeding concentrations have been documented. Potential displacement from prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. This deferral would buffer the blocks within the deferral by increasing the distance (effectively decreasing exposure to and high noise levels) between potential activities on adjacent, active OCS lease blocks. The effects analysis and conclusions indicate adverse effects would slightly decrease from those indicated under the Proposed Action. The effects under this alternative would not result in detectable population-level effects. Some whales would experience lower levels of fewer stress inducing events, but effects are considered to be the same as under Alternative 2.

This alternative would defer a large number of lease blocks (approximately 72.6%) from the Beaufort Sea sale area (Figure 2-1). The primary reductions in impacts of this deferral would be to exclude opportunity for large spills, disturbance, and collision impacts to endangered whales arising from exploration activities for the remainder of the 5-Year Program period. These sources of potential adverse effects would not occur in the deepwater portion of the lease area, where information is lacking on important endangered whale habitat and habitat use. While development is considered speculative, the elimination of potential launch areas and pipeline segments within the deferral area would eliminate spilled oil from these areas as well as potential OCS-related vessel-fuel spills and decrease the percent chance of a large spill contacting the whale habitat. Any OCS related infrastructure (pipelines) still could occur on these blocks, and potential for petroleum spills from these and vessel fuel spills still could occur, as noted in Section 4.4.2.6.1.3.9.

4.4.6.6.1.3.2. Cumulative Effects Under Alternative 6.

Summary. The cumulative effects under Alternative 6 are considered to be the same as those under Alternative 2, the Proposed Action.

As explained in Section 4.4.6.6.1.3.1, Direct and Indirect Effects under Alternative 6, the Deepwater Deferral would reduce impacts to endangered whales during the bowhead migration periods and period of concentrated summer-fall feeding; however, little is known about bowhead and other endangered whale habitat and habitat use in the deepwater area. Its large size, location, and lack of information regarding endangered whales limit rigorous evaluation of reductions in impacts. Conceivably, the effects analysis and conclusions may result in decreased effects compared to those under Alternative 2 but would be speculative at this time. The Deepwater Deferral would not allow oil- and gas-related activities during periods when endangered whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level reduces the total cumulative effect. Impacts to endangered whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have an adverse, moderate level of effect on whales. This is because there may be vessels continuing to transit to Canadian waters. The greatest source of large noncrude oil spills would continue to come from bulk fuel deliveries to Canadian and Alaska coastal villages and industrial operations. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for vessel-whale collision and propeller injury, marine accidents, and large fuel spills, which could result in major adverse effects on endangered whales in the Beaufort and Chukchi seas. Climate change is likely to continue and although speculative and unpredictable at this time, effects may be positive and/or adverse to endangered whales or their habitat in the Beaufort Sea. Continued monitoring, evaluation, and adaptive management actions to protect endangered whales and their habitats would be likely.

4.4.6.6.2. Threatened and Endangered Birds.

Summary. This deferral excludes an area that is not used by listed eiders. The cumulative effects are the same as those under Alternative 2.

4.4.6.6.2.1. Potential Effects to Threatened and Endangered Birds. The potential effects would be the same as those described in Section 4.4.1.6.2.1.

4.4.6.6.2.2. Mitigation Measures. Mitigation measures would be the same as those identified in Section 4.4.2.6.2.2.

4.4.6.6.2.3. Anticipated Effects Under Alternative 6. This deferral excludes an area that is not used by listed eiders. The anticipated effects under Alternative 6 are the same as under Alternative 2.

4.4.6.6.3. Polar Bear.

Conclusions. Alternative 6 would exclude all lease blocks north of the 100-m bathymetry contour. This deferral would reduce the overall footprint of the lease sale, and could protect some polar bear foraging habitat. The selection of this deferral would slightly decrease the adverse impacts of the effects determination for polar bears.

4.4.6.6.3.1. Direct and Indirect Effects Under Alternative 6. This deferral area would remove 4,357 lease blocks and partial lease blocks, or approximately 37,652 mi² from the lease sale. The direct effect of this alternative is to protect some seasonally used polar bear habitat. This is expected to reduce impacts to polar bears to a minor degree. Indirectly, this alternative also would protect ringed seal habitat, the primary prey of the polar bear. The distribution of ringed seals in the Beaufort Sea is strongly correlated seasonal ice, although they also range north into multiyear ice (Frost and Lowry, 1986). If deferred, this area would be protected from habitat alteration. Indirectly, deferring this area from the

lease sale would slightly reduce the possibility of a large oil spill contacting the Mackenzie River Delta. There is a 9-10% chance that a large oil spill in winter originating from LAs 23 or 25 would contact the Mackenzie River Delta area (ERA 89) within 180 days (Table A.2-117). Pack ice is the primary summer habitat of polar bears, and this deferral would provide protection for transitory habitat depending on the ice movements and conditions. (Schliebe et al., 2006.)

4.4.6.6.3.2. Cumulative Effects Under Alternative 6. Deferring this area reduces the overall footprint of the lease sale and, therefore, slightly reduces the cumulative effects compared to Alternative 2, the Proposed Action. This alternative would have a minor effect to the overall level of impacts to polar bears.

4.4.6.7. Marine and Coastal Birds.

Summary. This deferral would not change the adverse effects to marine and coastal birds to an appreciable extent compared to Alternative 2, because the deepwater habitats excluded are not used extensively by marine and coastal birds. The anticipated effects under this alternative are the same as under Alternative 2.

4.4.6.7.1. Potential Effects to Marine and Coastal Birds. The potential effects would be the same as those described for Alternative 2, the Proposed Action, in Section 4.4.1.6.2.1.

4.4.6.7.2. Mitigation Measures. Mitigation measures would be the same as those identified for Alternative 2, the Proposed Action, in Section 4.4.2.6.2.2.

4.4.6.7.3. Anticipated Effects Under Alternative 6. This deferral would not change the adverse effects to marine and coastal birds to an appreciable extent compared to Alternative 2, because the deepwater habitats excluded are not used extensively by marine and coastal birds. The anticipated effects under this alternative are the same as under Alternative 2, the Proposed Action.

4.4.6.8. Other Marine Mammals. Alternative 6 would offer about 1,766 whole and partial lease blocks in the lease sale area (Figure 2-1). The following analyses describe the anticipated effects under Alternative 6, the Deepwater Deferral, on marine mammals in the Alaska Beaufort Sea. The Deepwater Deferral constitutes about 71% of the Beaufort Sea lease sale area.

Ringed, Spotted, Ribbon, and Bearded Seals. The anticipated effects under this alternative to ice seals would be similar to those under Alternative 2.

Pacific Walrus. Walrus typically do not inhabit deepwater areas due to foraging constraints. This alternative would not change the effects determination of a negligible effect for walrus, as compared to those under Alternative 2.

Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale. The direct, indirect, and cumulative effects under this alternative may be slightly reduced compared to those determined under Alternative 2, the Proposed Action; but reductions in impacts are not substantial, and effects are considered to be the same (negligible to minor) as under Alternative 2. Baleen whales other than ESA-listed species that can occur within or near one or both of the Beaufort Sea and Chukchi Sea Planning Areas or that potentially could be adversely affected by activities within these planning areas are gray whales; however, current evidence indicates minke whales do not occur in the Beaufort Sea lease-sale area. Beluga whales are the only toothed whales known to regularly occur in the lease sale area.

4.4.6.8.1. Potential Effects to Marine Mammals. The potential effects for marine mammals in the Beaufort Sea were described in Section 4.4.1.8.1. Potential effects specific to whales that may apply also to gray whales are described in Section 4.4.1.6.1.1.

4.4.6.8.2. Mitigation Measures. The potential effects can be moderated by the mitigation measures identified in Section 4.4.2.8.2.

4.4.6.8.3. Anticipated Effects Under Alternative 6. In this section, we determine the anticipated level of effect on marine mammals if MMS opens the lease-sale area with the Deepwater Deferral in the Beaufort Sea. These anticipated effects consider mitigation measures described above. We defined the terms used to describe the anticipated level of effect in Section 4.4.1.8.3. The anticipated effects of implementing this alternative are separated into direct and indirect effects (Section 4.4.6.8.3.1) and cumulative effects (Section 4.4.6.8.3.2).

4.4.6.8.3.1. Direct and Indirect Effects Under Alternative 6.

Ringed, Spotted, Ribbon, and Bearded Seals. Deferring the deepwater zone from leasing could slightly lessen the indirect chance of disturbances occurring. However this deferral can be expected to result in added scrutiny of the leased areas through reallocation of resources, leading to a level of direct and indirect effects similar to those described in 4.4.2.8.3.1 for the Alaskan Beaufort Sea.

Pacific Walrus. This deferral area would defer 4,357 lease blocks and partial lease blocks, or approximately 37,652 mi² from the lease sale. There would be no change in the direct effects to walrus under this alternative as compared to those under Alternative 2. Indirectly, when comparing this alternative to Alternative 2, this alternative may reduce the chance of an oil spill contacting areas important to walrus by reducing the overall footprint of the lease sale.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. The Deepwater Deferral area, except the shelf break, is not likely to experience OCS oil and gas exploration activity in the near future due to the lack of technical ability to work and explore these deepwaters in the Arctic. The nature of deepwaters and low levels of known use by gray whales and beluga whales may not add substantially to protection of whale habitats for these species. Potential displacement from seasonal shelf break beluga whale prey concentrations and feeding would be reduced in some years from noise and vessel traffic related to OCS lease activities on the lease blocks identified in the deferral. The effects analysis and conclusions are slightly improved. The effects under this alternative would not result in detectable population-level effects. Some whales would maintain or slightly improve nutrient and energy intake over the life of the Proposed Action, but effects are considered to be the same as under Alternative 2.

This deferral would exclude disturbance and collision impacts to whales arising from exploration activities in these blocks for the remainder of the present 5-Year Program. These sources of potential adverse effects would occur farther away from a small portion of important migration and feeding habitats. While development is considered speculative, the increased distance between potential offshore launch areas and whale habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill-response time. Any OCS-related infrastructure (pipelines) to transport product would not be likely to occur on these blocks. Some vessel related fuel spills still could occur.

4.4.6.8.3.2. Cumulative Effects Under Alternative 6. Cumulative effects under this alternative are the result of combining the direct and indirect effects (described above) and the cumulative effects under Alternative 1, the no-action alternative.

Ringed, Spotted, Ribbon, and Bearded Seals. Cumulative effects would be similar to those described in Section 4.4.2.8.3.2.

Pacific Walrus. Deferring this area slightly reduces the overall footprint of the lease sale. Alternative 6 would not substantially change the anticipated level of effects of this lease sale for walrus. This alternative would have a negligible level of effect on walrus compared to Alternative 2, the Proposed Action. Walrus do not typically inhabit deepwater areas due to foraging constraints.

Beluga Whale, Killer Whale, Harbor Porpoise, and Gray Whale. The Deepwater Deferral would slightly reduce adverse effects to grey whales and belugas during migration periods and periods of concentrated summer-fall feeding; however, its small size limits the size of the reduction and the effects analysis and conclusions are only slightly improved compared to those under Alternative 2. The Deepwater Deferral would not allow oil- and gas-related activities during periods when whales are present or access to petroleum resources via extended-reach technology from adjacent active lease blocks. The reduced impact level slightly reduces the total cumulative effect.

Impacts to whales and habitats from activities unrelated to OCS leasing activities and potential oil and gas infrastructure developments would continue to have a moderate level of effect on whales. The anticipated increase in traffic from tourism, research, and/or shipping vessels could increase the potential for marine accidents and large fuel spills, which could result in major adverse effects on whales in the Beaufort and Chukchi seas. Trends in climate change are likely to continue and although speculative and unpredictable at this time, effects may be positive and/or adverse to whales or their habitat in the Beaufort Sea. The cumulative effects under this alternative are similar to those described under Alternative 2 in Section 4.4.2.8.3.2.

4.4.6.9. Terrestrial Mammals.

Summary. The impacts on terrestrial mammals under this alternative would be similar to those under Alternative 2, the Proposed Action.

4.4.6.9.1. Potential Effects to Terrestrial Mammals. Potential effects are described in Section 4.4.1.9.1.

4.4.6.9.2. Mitigation Measures. Mitigation measures are the same as described for Alternative 2, the Proposed Action, in Section 4.4.2.9.2.

4.4.6.9.3. Anticipated Effects Under Alternative 6. The anticipated effects under Alternative 6 are the same as those described for Alternative 2, the Proposed Action, in Section 4.4.2.9.3.

4.4.6.9.3.1. Direct and Indirect Effects Under Alternative 6. The effects are the same as those described for Alternative 2, the Proposed Action, in Section 4.4.2.9.3.1.

4.4.6.9.3.2. Cumulative Effects Under Alternative 6. The effects are the same as those described for Alternative 2, the Proposed Action, in Section 4.4.2.9.3.2.

4.4.6.10. Vegetation and Wetlands.

The effects to vegetation and wetlands under Alternative 6, Deepwater Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.6.11. Economy.

Effects to the economy under Alternative 6, Deepwater Deferral, would be the same as those under Alternative 2, the Proposed Action.

4.4.6.12. Subsistence-Harvest Patterns and Resources.

4.4.6.12.1. Effects Under Alternative 6 on Subsistence-Harvest Patterns.

4.4.6.12.2. Direct and Indirect Effects Under Alternative 6. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities in the deferral area would be expected. It should be noted that there is little industry interest in the area far offshore, as it holds little resource potential. Additionally, subsistence resources normally are harvested closer to shore, so the potential for disturbance to subsistence resources and practices is very low.

Conclusion. Effects to subsistence-harvest patterns are expected to be reduced as compared to Alternative 2, the Proposed Action, because no exploration or production activities would occur in the deferral area. Subsistence resources normally are harvested closer to shore, and the potential for disturbance to subsistence resources and practices from activities in this region would have been very low. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action. Resources in the deferred area still could be affected by a large oil spill that occurred elsewhere in the sale area. The extent to which this deferral reduces noise effects to subsistence resources and practices as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.12.3. Cumulative Effects Under Alternative 6.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts would be expected. Deferring this area would reduce the overall footprint of the lease sale, although subsistence resources normally are harvested closer to shore and the potential for disturbance to subsistence resources and practices from activities in the deferred area would have been very low. The extent to which this deferral reduces the cumulative noise effects to subsistence resources and practices as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.13. Sociocultural Systems.

4.4.6.13.1. Direct and Indirect Effects Under Alternative 6. No leasing, exploration, development, and production activities could occur in the deferred area. Subsistence resources normally are harvested closer to shore, so the potential for disturbance to subsistence resources and practices is very low.

Conclusion. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities as compared to Alternative 2, the Proposed Action, would be expected. Effects to sociocultural systems are expected to be reduced as compared to Alternative 2, the

Proposed Action, by this deferral alternative to the extent they reduce effects to subsistence-harvest patterns. Even though no exploration or production activities would occur in the deferral area, subsistence resources normally are harvested closer to shore, and the potential for disturbance to subsistence resources and practices and consequent effects on sociocultural systems from activities in the deferred area would have been very low. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area. The extent to which this deferral reduces noise effects to subsistence resources and practices and sociocultural systems as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.13.2. Cumulative Effects Under Alternative 6.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts as compared to Alternative 2, the Proposed Action, would be expected. Deferring this area would reduce the overall footprint of the lease sale, although subsistence resources normally are harvested closer to shore, and the potential for disturbance to subsistence resources and practices and sociocultural systems from activities in the deferred area would have been very low. The extent to which this deferral reduces the cumulative noise effects to subsistence resources and practices and sociocultural systems as compared to Alternative 2, the Proposed Action, would be negligible.

4.4.6.14. Archaeological Resources.

4.4.6.14.1. Direct and Indirect Effects Under Alternative 6. This deferral would prohibit leasing, exploration, development, and production activities on approximately 4,357 whole or partial blocks in far offshore in the Beaufort Sea.

Conclusion. The potential effects under Alternative 6 on archaeological resources are essentially the same as discussed under Alternative 2, the Proposed Action, except the deferred area would be removed from any bottom-disturbing activities. More potential effects are likely to occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Prehistoric and historic resources both onshore and offshore would be identified by archaeological surveys and avoided or mitigated.

4.4.6.14.2. Cumulative Effects Under Alternative 6.

Conclusion. Deferring this area reduces the overall footprint of the lease sale and, therefore, reduces the cumulative effects to archaeological resources as compared to from Alternative 2, the Proposed Action.

4.4.6.15. Environmental Justice.

4.4.6.15.1. Direct and Indirect Effects Under Alternative 6. By offering a reduced area for leasing, a reduction in adverse impacts from exploration, development, and production activities as compared to Alternative 2, the Proposed Action, would be expected. There is little industry interest in the area far offshore, as it holds little resource potential, and because subsistence resources normally are harvested closer to shore, the potential for disturbance to subsistence resources and practices is very low. The anticipated effects of activities resulting from a sale under Alternative 6 are expected to be essentially the same as under Alternative 2, the Proposed Action. On the other hand, the NSB, Dept. of Wildlife Management pointed out that resources harvested by Beaufort Sea coastal communities may use these areas farther offshore for feeding.

Conclusion. Effects on EJ are expected to be reduced as compared to Alternative 2, the Proposed Action, by this deferral alternative to the extent they reduce effects to subsistence-harvest patterns, sociocultural systems, and public health. Even though no exploration or production activities would occur in the deferral area, subsistence resources normally are harvested closer to shore, and the potential for disturbance to subsistence resources and practices from activities in this region is very low. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area. Therefore, the extent to which this deferral reduces noise and other adverse effects to subsistence resources and harvests, sociocultural systems, and public health, and, consequently, effects to EJ from Alternative 2, the Proposed Action would be negligible.

4.4.6.15.2. Cumulative Effects Under Alternative 6.

Conclusion. By offering a reduced area for leasing, a reduction in adverse cumulative impacts as compared to those under Alternative 2 would be expected. Deferring this area reduces the overall footprint of the lease sale, although subsistence resources normally are harvested closer to shore and the potential for disturbance to subsistence resources and practices from activities in this region is very low. The extent to which this deferral reduces noise effects to subsistence resources and practices, sociocultural systems, and public health, as compared to Alternative 2, the Proposed Action would be negligible.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.



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